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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Gaseous Fluid Ejector.

Large Floating Dock for Southampton.

Surface Condensing Plant and Auxiliaries.

The Shoe and Leather Fair—No. II.

Reinforced Concrete Bridge over a River in South India.

Electricity Supply.

The Student in the Factory.

British Commercial Gas Association.

The Bases of Modern Blast Furnace Practice.

110,000-Volt Electric Transformer.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

92 LOCOMOTIVE ENGINES AND TENDERS.

Tenders are being invited simultaneously in India and in England.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 16th January, 1923.

T. RYAN,
Director-General.

544

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

1. TYRES, STEEL, for RAILWAY CARRIAGE and WAGON WHEELS.
2. SPRINGS, LAMINATED, BEARING and BUFFING, for LOCOMOTIVE ENGINES, &c.
3. AXLE-BOXES, ENGINE, CAST STEEL.
4. WHEELS and AXLES.
5. STEEL, MILD, HEXAGON BARS.
6. BRASS and COPPER BOLT or ROD.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 7th November, 1922, for No. 1, on Thursday, the 9th November, 1922, for No. 2, and on Friday, the 10th November, 1922, for Nos. 3 to 6.

T. RYAN,
Director-General.

551

Mining School, Portsmouth.

A VACANCY exists for an ENGINEER to TAKE CHARGE of DESIGN.

Salary £300, rising by annual increments of £15 to £400 and full Civil Service bonus.

Commencing salary, including bonus at present payable, £449 12s. 9d.

The bonus is subject to an increase or decrease based on cost of living.

The post will carry superannuation benefits under the Federated Universities Superannuation Scheme.

Good technical qualifications are required, a degree or diploma in engineering being desirable. Experience in Engineering Design for Automobile or similar Work is essential. A general knowledge of engineering shop practice and production methods will be taken into consideration.

Applications should be made to the SECRETARY, Admiralty (C.E. Branch), London, S.W. 1. 546

Auckland Harbour Board, New Zealand.

TENDERS are INVITED for the SUPPLY and DELIVERY of :—

TWELVE (12) 5-Ton (and alternatively for 3-Ton) Semi-portal Balanced Jib ELECTRIC QUAY CRANES.

FOUR (4) 5-Ton (and alternatively for 3-Ton) Balanced Jib ELECTRIC ROOF CRANES.

SIX (6) 1-Ton ELECTRIC MONO-RAIL CRANES.

Specifications, diagrams and forms of Tender can be obtained at the office of the Board's Agents,

Messrs. W. and A. McArthur, Ltd.,
18/19, Silk-street,
Cripplegate, London, E.C. 2,

on payment of a deposit (returnable) of Two Guineas.

Tenders to reach Auckland by Noon on February 1st, 1923, addressed "The CHAIRMAN, Harbour Board, Auckland, New Zealand." 9008

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 8th November, TENDERS for the SUPPLY of :—

1. OVERBRIDGE.
2. STEEL MATERIAL for CONSTRUCTION of WAGONS, &c.
3. WHEELS and AXLES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for Nos. 1 and 2 and 10s. each for No. 3 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France,
Westminster, S.W. 1.
17.10.22. 503

County of London.

EDGE OF DOGS PUMPING STATION ENLARGEMENT.

The London County Council invites TENDERS for the CONSTRUCTION of an ENGINE-HOUSE in brick and concrete with slate roof, internal dimensions 74ft. by 48ft. by 33ft., with area of tarred paving above and 7ft. below ground, and FOUNDATIONS for Engines, Pumps and Auxiliary Machinery; also the CONSTRUCTION of SUPPLY, SUCTION and DELIVERY CULVERTS, and a PENSTOCK CHAMBER and other subsidiary works. The work will be situated in the Metropolitan Borough of Poplar.

The specification, form of Tender, &c., may be obtained on and after Monday, 23rd October, on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received after 4 p.m. on Monday, 20th November, 1922, will be considered. The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.

548

Madras and Southern Mahratta Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

7000 YARDS NAVY SAIL CANVAS (for HOSE PIPES), and 2500 YARDS WHITE NAVY DUCK,

in accordance with the specification, which may be seen at the office of the Company. The charge for the specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 31st October, 1922, marked "Tender for Canvas."

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices,
25, Buckingham Palace-road,
Westminster, S.W. 1,
17th October, 1922. 567

PUBLIC NOTICES

State Electricity Commission of Victoria.

TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification may be obtained or inspected upon application to :—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/4.—STEAM TURBINE-DRIVEN BOILER FEED PUMPS.

CHARGE.—£1 1s. for the first two copies of Tender form, conditions of contract and specification complete. These charges will be returned on receipt of a bona fide Tender. A third and any further copies will be supplied for the sum of 10s. 6d. each.

PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 3 p.m. on 19th January, 1923.

R. LIDDELOW,
Secretary.

State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 562

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of :—

1. MILD STEEL BARS, SECTIONS, &c.
2. YORKSHIRE IRON.
3. WROUGHT IRON.
4. SPRING STEEL.
5. BOLTS, NUTS AND RIVETS.
6. HEMP AND COTTON FABRICS, &c.
7. CARRIAGE UNDERFRAMES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Mild Steel Bars, Sections, &c.," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 3rd November, 1922, in respect of Nos. 1 to 6, and not later than Twelve Noon on Friday, the 17th November, 1922, in respect of No. 7.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1 to 6, and of £1 for each copy of Specification No. 7.

Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
19th October, 1922. 569

County Borough of Halifax.

ELECTRICITY DEPARTMENT.

The Tramways and Electricity Committee of the Halifax Corporation have FOR SALE the following :—

2 BABCOCK and WILCOX WATER-TUBE BOILERS, complete with CHAIN-GRATE STOKERS.

The above-mentioned boilers may be inspected at the Corporation's Power Station, Foundry-street, Halifax, by arrangement, and full particulars obtained on application to Mr. W. M. Rogerson, M.I.E.E., Borough Electrical Engineer, 29, Northgate, Halifax.

Tenders for the above plant should be delivered to the Town Clerk, Town Hall, Halifax, not later than Saturday, November 4th next.

The highest or any Tender not necessarily accepted.

By Order,
PERCY SAUNDERS,
Town Clerk.

Town Hall, Halifax,
6th October, 1922. 483

PUBLIC NOTICES

Selby Urban District Council.

The above-named Council invite TENDERS for the ERECTION of a GIRDER or FERRO-CONCRETE BRIDGE.

Plans and specifications to be sent in by contractors.

The Council do not bind themselves to accept the lowest or any Tender or Design.

Particulars may be obtained at my office.

BRUCE GRAY, A.M.I.C.E., F.R.S. (Edin.),
Council Offices, Selby. P6235

The Metropolitan Asylums Board invite TENDERS for DOCKING and UNDOCKING the AMBULANCE STEAMER "RED CROSS," in accordance with specification prepared by Mr. Thomas Cooper, M.I.C.E., Engineer-in-Chief to the Board.

Specification, conditions of contract and form of Tender may be obtained at the office of the Board, Embankment, E.C. 4.

Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 10 a.m. on Saturday, 4th November, 1922.

G. A. POWELL,
Acting Clerk to the Board.

566

Chief Engineer Required by the POSTS and TELEGRAPHS DEPARTMENT of the SUDAN GOVERNMENT.

Candidates should not be less than 35 years or more than 40, preferably unmarried, and must have intimate knowledge and practical experience of Telegraph, Telephone and Wireless Details as will enable them to undertake the management of 70 telegraph offices, 4000 miles of pole line, telephone systems at Khartoum, Khartoum North, Omdurman, and at various out stations, the wireless system at 15 stations and the installation of new stations, the telegraph clearing house, and the management of the staff at the various stations. A slight knowledge of administrative duties will be very valuable. Permanency if found satisfactory after two years' probationary period. Strict medical examination. Free passage out to the Sudan. One period of leave during the probationary period, subject to the exigencies of the service. Salary £E852 per annum plus a war bonus in accordance with the rules for the time being in force as long as war bonus is being paid. The present bonus is £E84 per annum (£E1 equals £1 0s. 6d.).

Applications for further details of qualifications, duties and conditions of service should be made to the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1. Envelopes to be marked "Chief Engineer." 570

SITUATIONS OPEN

WANTED, an ASSISTANT MANAGER for Small General Engineering Works on Tees-side. Must be a capable engineer and experienced in estimating and interviewing.—Address, with references and stating salary required, 580, The Engineer Office. 580 A

WANTED, Enterprising and Experienced MAN to TAKE SOLE SALES CONCESSION of a newly invented SMALL TOOL SPECIALITY for Engineers' Workshops. Must be capable of organising all sales for the United Kingdom and of getting into touch with travellers having introductory facilities to all engineering establishments.—Address fullest particulars, P6274, The Engineer Office. P6274 A

ELECTRICAL ENGINEER FOR INDIA.

WANTED IMMEDIATELY, a qualified ENGINEER, with special experience in Industrial and Power Plants. Must have technical and some selling experience. Single man preferred. Maximum age 35. Salary from £800 upwards, according to qualifications. Send immediately application in own handwriting, with full particulars of training and experience and age, together with copies of testimonials.

Address, 582, The Engineer Office. 582 A

SITUATIONS OPEN (continued)

A LARGE FIRM of IRONFOUNDERS and MAKERS of STRUCTURAL STEEL WORK are DESIROUS of APPOINTING a FIRM or GENTLEMAN as their REPRESENTATIVE in South Wales.

Applicants are required to have an influential connection with Gas, Iron and Steel, Coal, Chemical and other allied undertakings.

The fullest particulars, including sources of reference and scale of remuneration suggested, may be sent to 575, The Engineer Office. 575 A

AN ENGINEERING TRADE JOURNAL has an OPENING for a YOUNG MAN with practical engineering experience and knowledge of Press Work to act as SUB-EDITOR.—State experience and salary required to Box 176, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 561 A

CONSULTING ENGINEERS REQUIRE a SENIOR ASSISTANT ENGINEER for Preparation of Reports and Estimates, principally in connection with Railway Electrification; good theoretical training and some practical experience essential; remuneration about £700 per annum, depending on qualifications.—Address, stating age and experience, P6284, The Engineer Office. P6284 A

ENGINEER.—A FIRM of CONSULTING ENGINEERS REQUIRE First-class ENGINEER to represent them in India. Must have good Electrical and Railway Engineering Experience. State age and salary required and when available.—Address, 578, The Engineer Office. 578 A

ENGINEER REQUIRED for Company Manufacturing Jams and other Preserved Provisions. Applicants must be fully qualified, having experience in the Production and Use of Steam for Manufacturing Purposes preferred.—Address, stating age, salary required, and full particulars of qualifications and experience, P6270, The Engineer Office. P6270 A

REQ. by London FIRM, Ltd. Co., WORKS MANAGER; invest £1000 in shares. Salary £416, dividend and com. Mfring. motor cycles, power units, &c. Refs. req. Balance sheet for inspection.—Messrs. TITCHFIELD, 23, Great Titchfield-street, Oxford-circus, London. 574 A

SMART PORTABLE RAILWAY SALESMAN REQUIRED for Glasgow district; must have had previous experience. Letters, stating age, qualifications, salary required, &c., to be sent in confidence.—Address, P6296, The Engineer Office. P6296 A

THE DIRECTORS of the LANGLOAN IRON and CHEMICAL CO., Ltd., of Coatbridge, invite APPLICATIONS in strict confidence for the POSITION of GENERAL MANAGER of their business. The works embrace five coal blast-furnaces, with ore briquette, residuals recovery, and cement making plants.

Applicants will please address the CHAIRMAN of the COMPANY, before November 6th next, stating age, scientific qualifications, actual experience in practical management of works, general commercial training, and lowest remuneration entertained.

Testimonials not required in the first instance, but references, from whom inquiries can be made, may be given. P6265 A

WANTED, DRAUGHTSMAN-ESTIMATOR for Tube Works, accustomed to laying out complete Steam and General Pipe Installations.—Address, 548, The Engineer Office. 548 A

WANTED, First-class JUNIOR DRAUGHTSMAN IMMEDIATELY: knowledge of Internal Combustion Engines an advantage. Please give full particulars of experience and salary required.—Address, 554, The Engineer Office. 554 A

WANTED, TWO Experienced DRAUGHTSMEN, accustomed Designing Structural Steel Work.

TWO experienced DRAUGHTSMEN, accustomed workshop details, Structural Steel Work. First-class men only wanted.

Apply, letter, SIR WILLIAM ARROL and CO. (Swansea), Ltd., King's Dock, Swansea. P6260 A

DRAUGHTSMAN, Fully Qualified, WANTED, experienced in the Design of Cold-starting Heavy Oil Engines, by old-established firm in the Midlands.—Write full particulars, stating salary, Box 870, Sells' Advertising Offices, Fleet-street, E.C. 4. 589 A

DRAUGHTSMAN REQUIRED, with Experience in Metallurgical and Steel Works Furnaces of all kinds and with sound mechanical knowledge. Must thoroughly understand technical German.—Write, "DRAUGHTSMAN," c/o Taylor's, 30, Fleet-street, London, E.C. 4. 550 A

DRAUGHTSMAN WANTED, with Sound Mechanical training, for works in Midlands. Some Electrical and Building Construction knowledge desirable.—Address, giving particulars of experience, age, and wages required, P6266, The Engineer Office. P6266 A

SITUATIONS OPEN (continued) Page II.

SITUATIONS WANTED, Page 2.

PARTNERSHIPS, Page 2.

PATENTS, Page 2.

MACHINERY, &c., WANTED, Page 2.

FOR SALE, Pages 2, 3 and 4.

AUCTIONS, Pages 3 and 104.

PREMISES TO LET OR WANTED Page 3.

WORK WANTED, Page 4.

AGENCIES, Page 2.

MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 415, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 103.

SITUATIONS OPEN (continued)

DRAUGHTSMAN WANTED, with Experience in Elevator and Conveyor Work.—Write, stating age and salary required, "C. X.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 571 A

ENGINEER DRAUGHTSMAN.—LONDON FIRM OFFERS permanent and progressive POSITION for steady capable MAN. State fully experience, qualifications, age, and salary required.—Address, P6287, The Engineer Office. P6287 A

BRIDGE WORKS FOREMAN REQUIRED for Chinese Government Railways; experience in Plate and Lattice Girder Construction and General Structural Work essential. Two years' agreement with salary of £360 and £372 per annum, including free quarters.—Write, stating qualifications and past experience, age, physical fitness, &c., to "N. W.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 581 A

FIRST-CLASS DRAUGHTSMAN WANTED, Experienced in Designing and Detailing all classes of Steam and Electric Cranes.—Apply by letter, stating age, experience, and salary, to THOMAS SMITH and SONS (Rodley), Ltd., Steam and Electric Crane Works, Rodley, near Leeds. 483 A

JIG and TOOL DRAUGHTSMAN WANTED IMMEDIATELY (for London district), with first-class experience on Motor Chassis Work with reputable firms.—Address with all particulars, 576, The Engineer Office. 576 A

SITUATIONS WANTED

A COMPANY SECRETARY and COMMERCIAL MANAGER, with wide experience in modern engineering, machine tools and small tools trades, SEEKS similar POST with progressive firm requiring a capable man experienced in company secretarial work and control of commercial side of large business. Efficient organiser, enterprising and energetic.—Address, P6270, The Engineer Office. P6270 B

A.M.I.C.E., 14 Years' Experience on Important works, DESIRES responsible POST as CONTRACTOR'S AGENT or RESIDENT ENGINEER. Practical knowledge of steel erection, also foundations, workshop buildings and railway work.—Address, P6249, The Engineer Office. P6249 B

A 5 WORKS MANAGER, Thoroughly Practical, Well-educated Engineer, sound shop and D.O. experience, loco., steam, general engineering, millwrighting, ironfoundry and repair work. Past 12 years successful control of labour as foreman and works manager.—Address, P6277, The Engineer Office. P6277 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st., E.C. 565 B

CIVIL ENGINEER (30), Diploma University of Zurich; 8 years' practical experience in design and erection of reinforced concrete work, fluent French and German, SEEKS responsible POST, England or Colonies.—Address, P6261, The Engineer Office. P6261 B

ENGINEER DESIRES APPOINTMENT Abroad; lately engineer and works manager for large chemical works in Glasgow, 7 years responsible engineer's position in Argentine, 7½ years engineer at large gas and constructional engineers in England; speaks Spanish.—Address, P6227, The Engineer Office. P6227 B

ENGINEER REPRESENTATIVE, with 20 Years' practical, technical and commercial experience, REQUIRES APPOINTMENT as REPRESENTATIVE or other responsible position with first-class company.—Address, P6278, The Engineer Office. P6278 B

ENGINEER, to Take Charge of Heavy Oil or Gas Engines. Varied experience in shops, outside erection and repairs; at present with leading makers.—Address, P6286, The Engineer Office. P6286 B

FOUNDRY MANAGER or ASSISTANT DESIRES POSITION. Practical experience in green, dry sand and loam; well up in modern methods of machine and plate moulding, jolt ramming machines and oil sand cores.—Address, P6264, The Engineer Office. P6264 B

MECHANICAL ENGINEER, First Class B.O.T. certificate, extensive practical experience in running of large modern plants, capable of supervising repairs and handling men, DESIRES APPOINTMENT as ASSISTANT ENGINEER; age 34.—Address, P6272, The Engineer Office. P6272 B

PRODUCTION ENGINEER (36) DESIRES ENGAGEMENT in any capacity; nine years as assistant and works manager with large firm of repetition engineers, handling accurate machined parts for the motor car, electrical and general engineering trade. Wide experience in the control of labour, costing, estimating, rate fixing, tool design and machine production; good references, moderate salary.—Address, P6275, The Engineer Office. P6275 B

TWO Thoroughly Practical MECHANICAL ENGINEERS are OPEN to OFFER their JOINT SERVICES in the REPAIR and UPKEEP of FACTORY MACHINERY or MOTOR WORK in London.—Address, P6273, The Engineer Office. P6273 B

TO PROSPECTIVE MANUFACTURERS AND MANUFACTURERS OF HEAVY OIL ENGINES, HOT BULB AND COLD STARTERS.

TWO ENGINEERS, long experience with successful firms in design, experiments and production of above types of engines, OFFER their SERVICES.

Can guarantee to place a line of efficient, simple and reliable engines on the market in minimum time. No experimental period necessary. Progressive salaries depending on results.

Address, P6263, The Engineer Office. P6263 B

WORKS MANAGER of Large Motor Works in Midland Counties for the past four years RE-QUIRES similar POST or as ASSISTANT MANAGER to leading concern; expert in modern tooling methods for low cost and accurate production; 17 years' experience with leading concerns, M.I.A.E., M.I.P.E.—Address, P6262, The Engineer Office. P6262 B

YOUNG, Keen, Energetic and Ambitious ENGINEER SEEKS CHANGE of BERTH; practical and D.O. experience, good education, and studying at present for A.M.I.M.E.; preferably position with responsibility and advancement.—Address, P6276, The Engineer Office. P6276 B

DRAUGHTSMAN (Junior), 4½ Years' D.O. and W. exp., general mechanical work; well recommended; DISENGAGED.—ALLEN, 82a, Garthorne-road, S.E. 23. P6271 B

DRAUGHTSMAN (JUNIOR) SEEKS PROGRESSIVE POST. Five years shops (practical), three years D.O., technical and practical; experience plant lay-out, factory maintenance and machine details. Excellent references.—Address, P6294, The Engineer Office. P6294 B

DRAUGHTSMAN, JUNIOR (24); 7 Years' D.O. experience, general engineering; 3 years' technical training, practical and theoretical; good references.—L. F. H., 25, Windsor-road, Thornton Heath. P6298 B

SITUATIONS WANTED (continued)

EXPERIENCED Young Mechanical DRAUGHTSMAN; 7 yrs. works, D.O., and tech. school; disengaged Oct. 21st; thoroughly competent in detail, knowledge turbine design, structural and motor engines; mod. salary for permanent and progressive post.—44, Herbert-gardens, Willesden, N.W.10 P6297 B

JUNIOR DRAUGHTSMAN SEEKS ENGAGEMENT; 5 years D.O., 2 years technical, age 19 years. Low salary accepted for good opening.—Address, A. D., 44, Leamore-road, Hammersmith. P6291 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, and general engineering, DESIRES SITUATION; London or South Coast.—Address, P6292, The Engineer Office. P6292 B

YOUNG MAN (19) SEEKS SITUATION in Engineer's Drawing-office. Three years' technical education; knowledge of French and mechanical drawing; salary of secondary importance.—Address, P6281, The Engineer Office. P6281 B

YOUTH (17½) SEEKS SIT. with Engin. Firm, Anywhere, to Learn some branch of Draughtsmanship. Good sec. school educ.; Bennett Col. Diploma in Draughts.—Address terms, P6295, The Engineer Office. P6295 B

BOILERMAKER Well Up in Boiler and Fire-box Repairs, SEEKS EMPLOYMENT; ex-Service.—F. C., Smith's Library, Dorchester. P6241 B

SMITH SEEKS JOB Anywhere; Used to Engineers, Locomotive and repairs; young, energetic.—Address, P6288, The Engineer Office. P6288 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co., 46, Watling Street, London, E.C. 4.

Established seventy years.

A.M.I.C.E. (36), Public School Education, SEEKS PARTNERSHIP with established firm consulting engineers or contractors with overseas connections. Sound experience, capital to £10,000.—Address, P6260, The Engineer Office. P6260 C

PUPILS and APPRENTICES

ARTICLED PUPIL.—CIVIL ENGINEER Has VACANCY for well-educated YOUTH. Interesting works in hand. Premium required.—Address, 459, The Engineer Office. 459 B

MISCELLANEOUS

ADVERTISERS are BUYERS of Used RAPE OIL, such as has been used for tempering work, &c. Advise quantities available and price.—Address P6077, The Engineer Office. P6077 I

PATENTS

INVENTIONS DEVELOPED, PATENTED, and SOLD for Clients by Engineers (late of Vickers Ltd., B.Sc., M.R. Ae. S., A.M.I. Ae. E.). Strictest confidence, most moderate terms.—FORTIS and PARTNERS, 60, Queen Victoria-street, E.C. 4. Tel., Cent. 2864. 512 B

THE PROPRIETORS of the Following LETTERS PATENT:—

Nos. 22,191/1907 and 16,125/08, relating to
MULTI-SPINDLE METAL-WORKING MACHINES;

No. 22,816/11, relating to
SCREW-MAKING MACHINES;

No. 112,780, relating to
SCREW-CUTTING TAPS;

and No. 120,090, relating to
DRILL MACHINES;

DESIRE to DISPOSE of their PATENTS or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the Patents in this country.—Inquiries to be addressed to

CRUIKSHANK and FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 352 B

THE PROPRIETOR of BRITISH PATENT No. 15,664/11, for "A New or Improved Manufacture consisting of a Cooked Digestible Chocolate and the Machinery and Process for Producing same," DESIRES to INTRODUCE his INVENTION to the notice of manufacturers and others with a view to the invention being worked commercially under LICENCE or otherwise.—All communications to be addressed to JENSEN and SON, Chartered Patent Agents, 77 Chancery-lane, London, W.C. 2. 530 B

THE OWNERS of PATENTS Nos. 102,624 of 1914, for "Improvements in Multi-cylinder Motors with Radially Arranged Cylinders"; 113,466 of 1917, for "Improvements relating to Internal Combustion Engine Cylinders"; 118,159 of 1917, for "Improvements relating to Pumps"; 128,652 of 1917, for "Improvements relating to Internal Combustion Engine Cylinders"; 128,653 of 1917, for "Improvements relating to Internal Combustion Engine Valve Mechanism"; 132,154 of 1918, for "An Improved Bracket for Supporting Accessories of Internal Combustion Engines"; 140,529 of 1918, for "Improvements in Connecting Rod Big Ends for Internal Combustion Engines"; 140,545 of 1918, for "Improvements in Shock Absorbers for Aeroplane Radiators"; 145,398 of 1919, for "Improvements in Springs for the Valves of Explosion Motors," are DESIROUS of NEGOTIATING with interested parties for the GRANTING of LICENCES thereunder on reasonable terms.—For information write Messrs. LLOYD WISE and CO., Chartered Patent Agents, 10, New-court, Lincoln's Inn, London, W.C. 2. 560 B

THE PROPRIETORS of the BRITISH PATENTS No. 16,188/1914, for "Improvements relating to the Lateral Shifting Mechanism for the Totalisor Carriages of Calculating Machines"; No. 160,466, for "Division Mechanism for Calculating Machines"; No. 166,487, for "Improvements in Totalizer Transfer Mechanism for Calculating Machines"; 166,488, for "Improvements in Keyboard Setting Mechanism for Calculating Machines"; and No. 166,489, for "Improvements in Calculating Machines," DESIRE to ENTER into NEGOTIATIONS with a Firm or Firms in Great Britain for the purpose of EXPLOITING the inventions by way of LICENCE upon reasonable terms or for the SALE of the PATENTS.

Communications should be addressed in the first instance to Messrs. BROWNE and CO., 9, Warwick-court, Gray's Inn, London, W.C. 1. P6259 B

EDUCATIONAL

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For continuation of For Sale Advertisements see page 3.

The Gaseous Fluid Ejector.

By HENRY A. HEPBURN, B.Sc. (Lond.), A.M.I. Mech. E.

No. 1.

THE extended use of kinetic principles as distinct from piston force action, or in addition to that action, for the production and maintenance of high vacua in condensers is so significant that an outline of the theory of ejector action may be of some interest. Design at present appears to be based on purely empirical formulæ, which may be of profound importance in proportioning details of new apparatus, but which do not allow of imaginative conceptions for future development. The writer will present the various factors in rather a new light, which shows clearly the relationship between the fundamentals of the problem and also gives an opportunity of forecasting the design of more efficient types of ejector apparatus. An examination of the various condenser ejector systems now in vogue shows a general similarity in the methods employed, with a slight, but in one case important, variation in the manner of treating the combined induced air vapour and nozzle steam during the time of mingling and subsequent compression. The mere production of a desired vacuum pressure in a condenser should not be the only aim of the designer; the economy of the process must have serious consideration in these days of high efficiency search. So far as the writer can see, very few, if any, systems are mechanically and theoretically sound in principle. It will be shown that the action of the steam jet in producing the vacuum pressure is quite in consonance with established knowledge, and that if a required performance is postulated there is only a limited range of conditions that will cause the desired effect.

An investigation into the present state of knowledge, as published, shows that it is commonly known that steam or gas that issues with a high velocity from a suitably designed nozzle will produce a partial vacuum in the annular space surrounding the exit area. It is evident that a fluid at a pressure greater than that of the vacuum may be induced to flow into that area of lower pressure, and that by sharing its own kinetic energy with the vacuum-creating fluid the combined stream may be compressed in a suitable apparatus and discharged into a higher pressure region. That delivery pressure may be greater than either of the initial pressures of the constituent streams.

If water be the induced fluid, it is known that its initial temperature in the ejector is an important factor in securing continuity of flow, inasmuch that if the steam jet be not condensed the action ceases. The continuity of flow cannot be ensured with an enhanced amount of live steam.

One reads statements to the effect that the vacuum pressure in the condenser is unaffected by a range in initial pressure of the operating steam; obviously, since the kinetic energy of the jet depends partly upon the initial pressure, the statement cannot be rigidly true. It will be shown that the statement is only approximately correct, and that a relatively smaller range in vacuum pressure is produced by a given variation in initial ejector nozzle pressure. It is known that comparatively low-pressure steam obtained from the exhaust of a steam engine may be used for feeding the high-pressure boiler, or for performing other work involving a higher discharge pressure.

The steam turbine has reached a stage of development when higher thermo-dynamic efficiency can only be obtained by raising the initial pressure of and superheating the steam and or by lowering the vacuum pressure. Both of these artifices are steadily being adopted, and it is to the depression of the vacuum pressure that efforts are being particularly devoted, since elevation of boiler pressure and temperature of superheat leads to so many other familiar problems.

The vacuum augmentor system used by Parsons is well known and appears to be the first application in a serious way of what may be called the "cascade" or "series" effect, which will be explained later. The extending use of kinetic means for vacuum maintenance appears to be due to the fact that a piston extractor produces a limiting value of the condenser pressure beyond which it cannot go. Atmospheric air leaks in past the valves or the piston, and although refinements in design, such as light multiple disc valves, may be adopted, the vacuum is still capable of extension if leaks back could be eliminated. The kinetic ejector, by dispensing with valves and by substituting a momental flow force for piston area force, immediately stops leaks back, and if the efficiency could be made equal to that of the piston extractor, the latter would, no doubt, be soon superseded. The lines of possible development will be discussed.

THEORY OF DEPRESSION.

The action of a freely expanding elastic fluid jet will now be considered when issuing from a source of high pressure in such a way that the jet can expand to a lower pressure than the normal back pressure. The velocity of the jet will be assumed to be that as given by the St. Venant theory, *i.e.*, that the flow lines are parallel to the axis on exit. This assumption is not quite true, but will suffice for a broad outline of the events. The term "operating gas" will be used to designate the steam or gas that may be used to produce the vacuum, and the fluid that is induced to flow into the annular space surrounding the jet will be termed "induced gas."

Fig. 1 shows a P V diagram for the work done by unit mass of gas when expanding in any apparatus from an initial pressure p_1 down to a final pressure p_2. Let p_1 be a normal potential pressure and that consequently the "depression" pressure p_2 must be produced by doing work on the gas from a source not yet defined. At any stage of the expansion consider an element of the P V area $a\,b\,c\,d = p\,d\,v$. The work given up by the gas on expansion in any way is $\int_{v_1}^{v_2} p\,d\,v$, on the assumption that no energy is brought by the gas up to the point E, except its own intrinsic energy. The work done in depressing the pressure is $\int_{v_1}^{v_2} p_1\,d\,v$, and the net work required from an external source of energy is—

$$\int_{v_1}^{v_2} (p_1 - p)\,d\,v \quad . \quad . \quad . \quad (1)$$

and this is the area E D C. Assuming that the expansion law follows the type $p\,v^n$ = constant, and neglecting frictional and other losses for the moment, the area E D C may be represented by $A_r = \overline{A\,D\,C\,B} - \overline{A\,E\,C\,B}$.

$$\therefore A_r = (p_1 - p_2)\,V_2 - \frac{n}{n-1}(p_1 v_1 - p_2 v_2) \quad . \quad (1.1)$$

n being the assumed constant index of expansion. If now the gas be considered as in a state of uniform flow and a constant mass m of gas be brought to the point C in unit time, the work A_r per second to establish a "depression" pressure p_2 will be—

$$m\,A_r = \left\{(p_1 - p_2)\,V_2 - \frac{W_c^2}{2\,g}\right\} m \quad . \quad . \quad (1.2)$$

where $\frac{W_c^2}{2\,g} = \frac{n}{n-1}(p_1 v_1 - p_2 v_2)$.

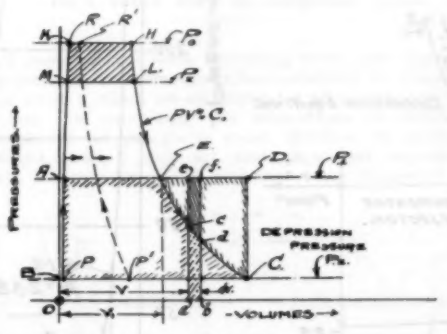


FIG. 1

The area of the nozzle exit section will be approximately $\frac{m\,V_2}{W_c}$, and once the flow is established no further depression work $m\,A_r$ will be required. The vacuum will then persist so long as the gas has a velocity at the point C sufficiently large to ensure compression back to the atmospheric or potential line p_1.

The compression work being $\frac{n}{n-1}(p_1 v_1 - p_2 v_2) = A_r$, in this instance being equal to the expansion work.

If e_e = the efficiency of the expansion process and e_c = the efficiency of the compression process, the work required to establish the depression pressure will become $(p_1 - p_2)\,v_2 - \frac{n}{n-1}(p_1 v_1 - p_2 v_2)\,e_e$, and to maintain that depression the work will become $\frac{1}{e_c} \times \frac{n}{n-1}(p_1 v_1 - p_2 v_2)$.

The difference

$$= E_L = \left(\frac{1}{e_c} - e_e\right)\frac{n}{n-1}(p_1 v_1 - p_2 v_2) \quad . \quad (1.25)$$

being additional work from the external source when contrasted with no loss flow.

Now, consider by what means the work A_r may be done. First, it can be obtained from a source that supplies energy to a piston extractor, or to a centrifugal type of pump. These are not germane to this theory and will not be discussed. Secondly, kinetic means may be adopted. Now, since p_1 has been postulated as being on a natural potential plane, all pressures tend to equalise themselves to it, and, therefore, if kinetic energy be employed for producing the pressure p_2, its original pressure state must be above that of the plane of p_1, otherwise energy would be abstracted from a system or space in equilibrium without the intervention of external forces, constant volume abstraction of heat being excluded from the analysis, so that the work A_r must be derived from above p_1. Continue the expansion line C E upwards with the same polytrope index "n" until the area $\overline{K\,H\,E\,A}$ = area $\overline{E\,D\,C}$. Then p_1 becomes the mean effective pressure of the expansion diagram $\overline{K\,H\,C\,B}$ and on free expansion in a suitable apparatus unit mass of gas will produce for itself a depression pressure p_2 as defined above.

If compression be assumed to take place under no-loss conditions with the same value of the index "n," then the area A E C B will be subtracted from the total energy area $\overline{K\,H\,C\,B}$, leaving the area $\overline{K\,H\,E\,A}$, which is, naturally, the available energy of the source referred to the natural potential sink pressure p_1. The work $\overline{E\,D\,C}$ will be done on the gas at rest in the apparatus and in setting up favourable conditions of flow for compression. Now, if the frictionless, no-loss compression be continued, the gas will finally reach the initial condition p_o v_o T_o with its original entropy. Suppose that the sum of the losses be known in terms of energy = E_L. Then the final compression would fall short of p_o by an area $\overline{K\,H\,L\,M} = E_L{}^1 = \frac{n}{n-1}(p_o v_o - p_2 v_2)$ approx., which is the lost energy.

Equation (1.1) may be written as—

$$A_r = \frac{p_1 - p_2}{p_2} R\,T_2 - \frac{n}{n-1} p_1 v_1 \left(1 - \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}\right) . \quad (1.3)$$

and

$$A_r = \frac{n}{n-1}(p_o v_o - p_1 v_1)$$

$$= \frac{n}{n-1} p_1 v_1 \left\{\left(\frac{p_o}{p_1}\right)^{\frac{n-1}{n}} - 1\right\} \quad . \quad (1.4)$$

and combining (1.3) and (1.4) gives—

$$\frac{p_1 - p_2}{p_2} R\,T_2 = \frac{n}{n-1} R\,T_2 \left[1 - \left(\frac{p_2}{p_o}\right)^{\frac{n-1}{n}}\right]$$

or

$$\frac{p_1 - p_2}{p_2} = \frac{n}{n-1}\left(1 - \left(\frac{p_2}{p_o}\right)^{\frac{n-1}{n}}\right) \quad . \quad (1.5)$$

a relationship between the pressures that is—in the case of constant "n"—independent of the temperatures and volumes, as would naturally be supposed.

This equation states that every adiabatic under the assumed conditions will give an equal depression when the working gas flows between the same upper limit and natural potential plane. It also indicates that, once a depression pressure is obtained, the energy of the gas may be diminished by—in the case of a gas other than steam—reducing the initial temperature, the exit flow area being presumed to be adjustable as the ratio $\frac{V_2}{W_c}$ varies on exit at C, provided always that the work of compression is available in the gas at p_2 pressure.

Let K be such that

$$\frac{W_c^2}{2\,g} = K \frac{n}{n-1} R\,T_2 \left\{1 - \left(\frac{p_2}{p_o}\right)^{\frac{n-1}{n}}\right\}$$

where K is the usual Energy Coefficient and is less than unity always, and K^1 is the velocity coefficient of the operating gas nozzle.

Then T_2, the assumed temperature at $C = \frac{p_2 v_2}{R}$ for frictionless no-loss flow, will be raised in proportion to the lost energy transformed into heat energy, suppose that all the losses can exist as heat, then—

$$\theta° = \frac{(1 - K)}{J\,C_p} \frac{n}{n-1} R\,T_2 \left\{1 - \left(\frac{p_2}{p_o}\right)^{\frac{n-1}{n}}\right\}$$

is the temperature rise per 1 lb. of gas, assuming a mean constant value of the specific heat C_p and that the heat is added to the gas at p_2 pressure.

Then—

$$\frac{p_1 - p_2}{p_2} R\,(T_2 + \theta) = K \frac{n}{n-1} R\,T_2 \left[1 - \left(\frac{p_2}{p_o}\right)^{\frac{n-1}{n}}\right]$$

which reduces to—

$$p_o = a\,p_2 \left[\frac{K\{x(n-1)+1\}}{K n - (n-1)(x-1)(1-K)}\right]^{\frac{n}{n-1}}, \quad (1.6)$$

where a is introduced as an experimental coefficient that can be deduced from known results and $x = \frac{p_1}{p_2}$. A similar type of relationship can be established for isothermal expansion, but such expansion is not met in this problem.

In the case where the specific heats vary with the temperature the equations become rather involved, and the temperatures appear in the expression for p_o and p_2.

If X_o = the energy liberated during a given temperature fall from T_o to T_2, then—

$$X_o = \int_{T_2}^{T_o} (\alpha + \beta t)\,d\,t \quad . \quad . \quad . \quad (1.7)$$

and if X_o and e_e be given T_o or T_e can be found from the quadratic equation that emerges from (1.7).

Then—

$$p_2 = \frac{p_1}{1 + \frac{X_o e_c}{R\left\{\frac{(1 - e_c) X_o}{J C_p} + T_e\right\}}} \quad . \quad . \quad (1.8)$$

or putting—

$$\frac{(1 - e_c) X_o}{J C_p} + T_e = \theta_e$$

$$p_2 = \frac{p_1}{1 + \frac{X_o e_c}{R \theta_e}} \quad . \quad . \quad . \quad . \quad . \quad (1.85)$$

and by the assumed adiabatic law for variable specific heats

$$p^\beta v^\alpha e^{\delta t} = \text{constant} \quad . \quad . \quad . \quad . \quad (1.86)$$

combined with $C_v = \beta + \delta t$ } $C_p = \alpha + \delta t$ } . . . . . (1.87)

the conditions of p_1, p_2, p_1, &c., can be determined; but for the purpose of investigating the lines of improvement in design the assumed constant value of $\frac{C_p}{C_v} = \gamma$ or of n will suffice.

Reverting to expression (1.6), it will be seen that, for a given value of depression x, great importance should be attached to having the value of n as high as possible. Fig. 3 gives a number of curves of p_o plotted against p_2 for values of $n = 1.1$, 1.2, 1.3, and 1.4, all arbitrarily chosen, and shows clearly that a high value of n means a lower p_o for any required p_2. This should have an important bearing on current practice. In one type of jet air extractor known to the writer the steam is highly superheated before expansion, and the value of n is therefore improved over the saturated and wet values. Again, the factors in the denominator $(n - 1)(x - 1)(1 - K)$ are usually such that their product is small except for small depressions, and it is interesting to note, therefore, that the losses in the nozzle on expansion do not greatly affect the pressures or vacuum obtained, as K cancels out of both numerator and denominator within the index brackets. K, however, has an important loss effect on the energy available, and must on that account be kept as low as possible. The angle of the diverging part of the operating nozzle must be kept as small as feasible without throttling the flow. An angle of 10 deg. is a good value, although it varies with the pressure p_2 through a small range. If the angle is much larger the radial energy increases rapidly and the available energy in an axial direction becomes less by a certain definite and calculable amount, which will not be dealt with here.

From the curves of Fig. 3 it will be seen that where p_1 is chosen as that of the atmosphere p_o rapidly assumes prohibitive values for low vacuums, so that a very low absolute vacuum is not economically obtained by a single ejector; but if one ejector can be arranged to deliver to the suction of a mechanically driven piston extractor, as in the Parsons augmentor, or to the suction of a second ejector, the value of p_o can be considerably lowered, as p_1 then becomes the value established by the pump or ejector, as the case may be, and a "cascade" effect is thereby obtained. It would appear, then, that where very low vacuums are desired, superheated exhaust steam might usefully be used in conjunction with a rotary or piston compressor for economically producing a very high vacuum.

Theory of Mass Induction.

So far it has been assumed that the velocity of the gas at the point C of Fig. 1 is that due to free expansion from H, but since the work required to be done per unit mass of gas in order to maintain the vacuum when produced is only the compression area $\frac{\text{A E C B}}{e_c}$, it follows that W_c may be reduced to a value W_c, where—

$$W_c = \sqrt{2g \frac{\text{A E C B}}{e_c}} \quad . \quad . \quad (1.9)$$

and this value is usually less than the value of W_c unless the losses are unusually high. Therefore an amount of energy $A_o = \frac{W_c^2 - W_c^2}{2g}$ is liberated for performing external work. If the exit velocity of the gas at the point E^1 in Fig. 4 is W_e, then

$$A_o = \frac{W_e^2}{2g} - \left(\frac{W_e^2 + W_c^2}{2g}\right) \quad . \quad (2.0)$$

the line C E^1 being the adiabatic line with losses, using the term in its usual loose form.

Again, since the amount of work required from the superior source per unit mass of gas in order to maintain the vacuum is $\frac{W_c^2}{2g}$, then if the mass of induced gas be m, and considering 1 lb. of operating gas, then—

$$m = \frac{W_e^2 - (W_c^2 + W_c^2)}{W_c^2} \quad . \quad . \quad (2.1)$$

or

$$m = \frac{W_e^2 - W^2}{W_c^2} \quad . \quad . \quad . \quad (2.2)$$

in which $\frac{W^2}{2g}$ = total energy at point C to compress the gases back to p_1 and $\frac{W_c^2}{2g}$ is the amount of energy required to just maintain the vacuum pressure p_2.

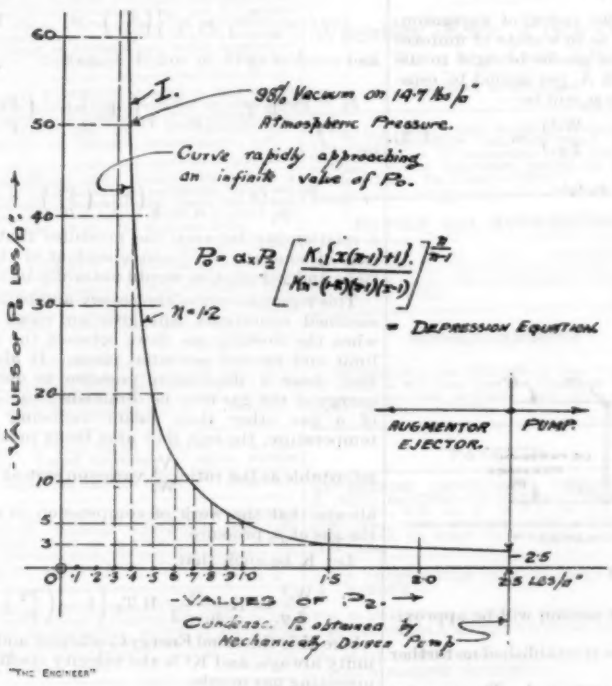


FIG. 2

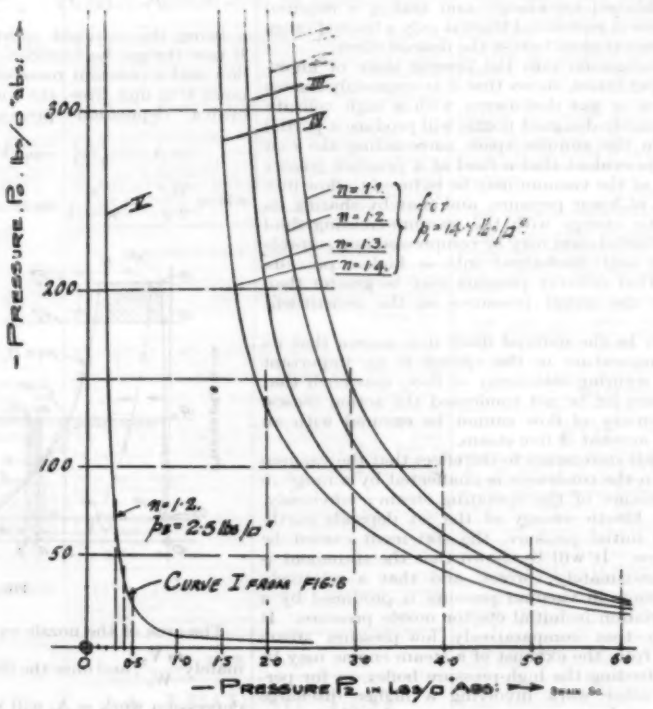


FIG. 3*

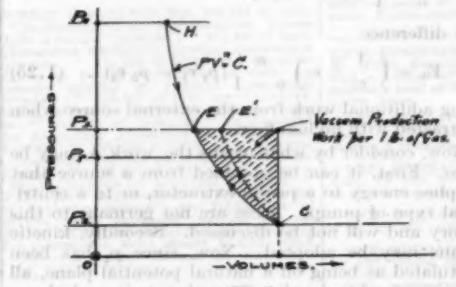


FIG. 4

The value of W_c may also be determined by considering the momental and pressure forces over the entry, critical and exit areas of flow, and leads to the same results, only in a much more cumbersome way.

It will be noticed that if the induced gas whose mass is m lb. flows from p_1 to p_2 under index n conditions, that it will bring its energy $\frac{W_c^2}{2g} = \text{A E C B} \times e_c$ and requires $\frac{\text{A E C B}}{e_c}$ for re-compression; but it must not be imagined that it could maintain its own vacuum if the difference $= \overline{\text{A E C B}}\left(\frac{1}{e_c} - e_c\right)$ were made up by the external source, if the superior pressure p_o were to be eliminated when flow commences. The depression is maintained by pressure differences independently of work, as expression (1.6) indicates, and that superior pressure p_o must always be maintained. By the principle of conservation of energy the gases upon again reaching the natural potential plane p_1 must have a combined energy equal to all supplied from the superior source minus losses, no other work being done by the gases.

In condenser practice the mass m brings very little work up to the jet, and consequently W is entirely absorbed in compression work, and therefore the combined gases leave the apparatus with the velocity W_c only.

It will be observed that m is the mass induced at the lowest value of p_2 that can be obtained with p_o gas; but, of course, a much larger mass may be induced for the same p_o at pressures higher than p_2—say, p_r, in Fig. 4—p_r being any arbitrarily chosen value. The area of flow of the gases will be correspondingly greater, and the operating gas will always tend to drop in pressure to p_2. From equation (2.2) above m can be infinite in value for small values of W_c, but is in general finite for practical purposes. It is obvious that in dealing with finite masses of induced gases at desired vacuum pressures it is most economical to work at the correct p_2 for a given p_o.

EXPERIMENTAL TIMBER PRESERVATIVE STATION.

The Forest Department of the South African Government is planning an experimental timber preservative station at Pretoria. The site has been selected, a small office and workshop is erected, a derrick and a vertical open tank have been installed. The first supply of posts, poles, and preservatives, has arrived, making it possible to commence experiments at once. The present equipment makes it possible to give a full non-pressure treatment to posts and a butt treatment to poles. A horizontal tank has been designed to make it possible to give a full treatment to poles, but it has not been installed yet. On account of the many species of wood that do not respond readily to open-tank treatment, the plans provide for an experimental high-pressure cylinder 24ft. long and 2¼ft. diameter, to be put to work during the present year. This plant will be equipped with heating coils and a steam spray inside, vacuum pump, force pump, and a condenser in connection with the vacuum pump, gauges, and thermometers, &c. The plant will be fully up to date, making it possible to carry out preservative treatment under a great variety of conditions, and the plant may also be serviceable for experimental seasoning of timber under vacuum. In addition to being of assistance in treatment of mining timbers, it is contemplated to experiment with cheap preservatives for farmers' fence, telephone and telegraph posts, &c.

* For Curve I from Fig. 6 read Curve I from Fig. 2.—Ed. The E.

Surface Condensing Plant and Auxiliaries.

In 1890 the manufacture of self-contained condensing plant was first taken up by W. H. Allen and Co., London, who claim to be the pioneers and inventors of the system, and since that time many of these simple plants have been built for use in this country and abroad. In the early stages of steam turbine development little information was available relative to the tube type of surface condenser or concerning water and air extraction equipment for high vacuum, but during the period 1902-1903 Mr. Richard W. Allen made some exhaustive tests on condensers, and the results were given in a paper entitled "Surface Condensing Plant and the Value of the Vacuum Produced," read before the Institution of Civil Engineers. Taking this paper as a basis for research, Professor Weighton carried out some further experiments which ultimately resulted in the development of the Contraflo condenser. The drawing, Fig. 1, shows the type of plant which was constructed in 1890, whilst Figs. 2 and 3 show the most recent plant which has been built for the Lots Road Station. The latter represents the maker's most recent practice and shows the layout of two 15,000 kilowatts sets, together with the air extraction and circulating water equipment.

As the result of continuous observation and experiment, the design of condensing plant has been greatly improved during the last few years, and the condenser is now one of the most efficient units employed in connection with power production. The efficiency of a condenser is dependent upon the even distribution of the steam over the surface and freedom from eddies and stagnant pockets, the general proportions of the cooling surface, and the quantity of circulating water used. An interesting Contraflo surface condenser recently built by W. H. Allen, Sons and Co., Ltd., for use in conjunction with a 10,000-kilowatt turbine is designed to condense 106,000 lb. of steam per hour and to maintain a vacuum of 28.7in. with the barometer at 30in. and with the circulating water at a temperature of 65 deg. Fah. The steam inlet extends round a large proportion of the circumference in order that the steam may immediately make contact with the maximum initial tube surface, and as a result of this design the area presented for the flow of steam between the tubes is the largest obtainable, and this large area, together with the comparatively short length of the steam path through the tubes, reduces the resistance offered to the flow of steam to a minimum. In order to avoid eddies and to provide a series of wedge-shaped compartments for dealing with aerated vapour at an exceedingly low pressure and correspondingly large volume has of course to be installed in order to maintain the high vacuum which the condenser is capable of giving.

The displacement type of pump, the makers of these condensers point out, does not adapt itself to these conditions, and after a considerable amount

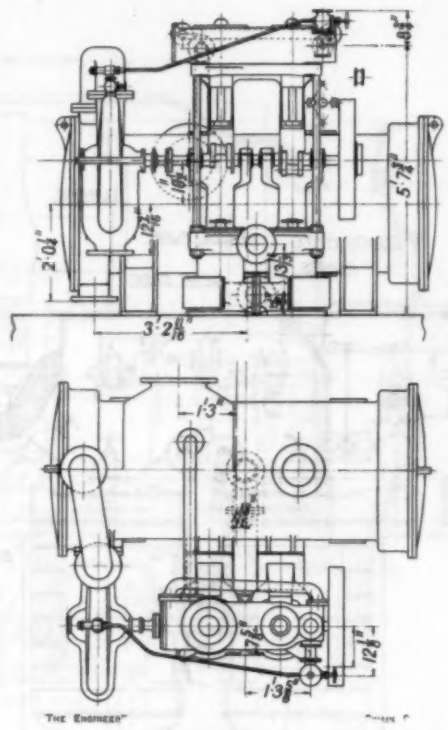


FIG. 1—EARLY TYPE OF CONDENSING PLANT

of experimental work extending over some years a good many manufacturers have adopted the practice of using a steam jet air pump for all power installations. In comparing the advantages of different types of air pumps it must, however, be remembered that a dry air test does not represent the working conditions, and that when connected to a condenser the pump has to extract from five to six times as much water vapour as air. Under favourable conditions this ratio can be reduced, but the real test for an air pump is the wet test. The Allen kinetic rotary air pump which has been applied to many important power plants, has a capacity when working with aerated vapour twice as great as when working with dry air, whilst the steam jet type of air pump, Messrs. Allen contend, is in general only able to deal with about 10 per cent. more aerated vapour than dry air.

The Allen steam jet air pump is shown in Figs. 4 and 5. The air and vapour are withdrawn from the condenser by a steam jet ejector which discharges into a receiver, where the steam and vapour come into contact with a spray of condensed water from the extraction pump discharge. The steam from the ejector is condensed and the resultant water returned to the condenser through a water-sealed balance pipe. A secondary steam ejector maintains a vacuum in the receiver, and as all such ejectors work under conditions which are liable to result in instability, a special patented design is adopted. It has been found that when the quantity of aerated vapour through a secondary ejector throat becomes too small adequately to fill the throat a state of instability is produced, and for a time the ejector is liable to fail completely. In most types of steam jet air pumps a spring loaded valve is provided which opens before the point of instability is reached and admits air from the atmosphere either into the receiver or into the throat of the ejector.

This scheme, Messrs. Allen point out, is generally undesirable, as it allows air to come into direct contact with the condenser vapours under circumstances which are very favourable for forming a really intimate mixture, and if an open condensate system is used this aerated water ultimately goes into the boiler and may give rise to corrosion. In the case of the kinetic secondary air ejector fitted to the condensers under consideration, however, no additional atmospheric air is admitted to the system, for when the quantity of aerated vapour is insufficient completely to fill the ejector throat a by-pass comes into action automatically and allows vapour to pass from the discharge side of the ejector directly into the throat until the latter is again completely filled, this action being instantaneous and ensuring the satisfactory working under all conditions of load. The secondary ejector discharges into a small surface heater where the heat of the steam used for operating the ejector is absorbed by the feed water, and the condensed water is returned to the system through a small tank with a float-operated ball valve which controls a suction pipe connected to a receiver in which this condensed water is de-aerated under the vacuum. In the case of some condensing plants for use in conjunction with large turbo-generator sets the arrangement shown in Fig. 10, page 414, has been adopted. In this case there are three steam jet extractors in series, designed to work under certain pressure differences, with intermediate condensers between the first and second and second and third extractors. The arrangement is somewhat more complicated than the two-jet systems, but the

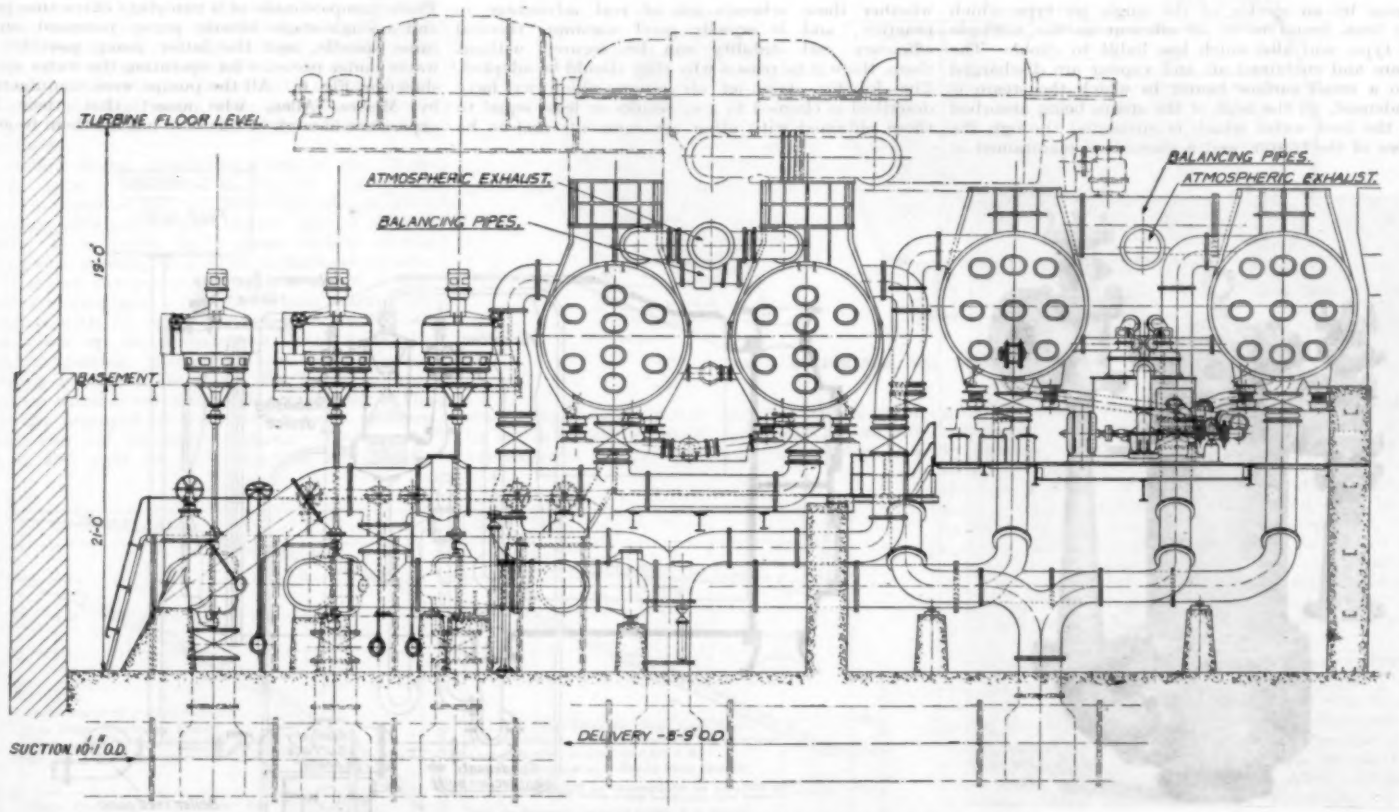


FIG. 2—ALLEN CONDENSING PLANT AT THE LOTS-ROAD POWER STATION, CHELSEA

gradually concentrating the air and vapour towards the narrow outlet leading to the devaporising chamber—through which the residual air and vapour are withdrawn by the air pump—guide vanes are provided. This design of condenser gives a high thermal efficiency and makes it possible to maintain a vacuum at the inlet flange closely approximating to the theoretical vacuum obtainable with a given hotwell temperature. An air pump capable of

advantage of this development arises from the high working efficiencies which result when three ejectors are arranged to work under certain compression ratios, and a very considerably reduced steam consumption is thereby obtained. The Allen kinetic rotary air pump, shown in Fig. 6, is arranged to work on a closed feed-water system, which is designed so that the main body of the feed water does not come into contact with the atmosphere during its return

from the condenser to the boiler. This system is now being very generally adopted in power stations, as it is recognised that excessive boiler deterioration is very largely due to the action of oxygen contained in aerated feed water, and that it is essential to employ all possible means for excluding the air from boilers. The air is withdrawn from the condenser by an ejector of the single jet type which has been found to be as efficient as the multiple jet type, and also much less liable to choke. The steam and entrained air and vapour are discharged into a small surface heater in which the steam is condensed, all the heat of the steam being absorbed by the feed water which is circulated through the tubes of the heater, and a vacuum is maintained in the steam space of the heater by means of a water-operated ejector which withdraws the air and vapour from the heater and discharges it into a small tank. In these systems practically all the heat in the steam which is used for working the ejectors is returned to the condensate and the overall efficiency is consequently the maximum obtainable.

The introduction of new engineering devices, the makers of these condensing arrangements point out, is usually followed by a number of similar arrangements which are claimed to be superior to the original device. Steam jet air pumps are, Messrs. W. H. Allen explain, going through this process, and makers are claiming better and more efficient results by the use of water jackets, radial steam jets, &c. It is considered doubtful, however, whether these schemes are of real advantage in practice; and if equally good vacuum, thermal efficiency and stability can be secured without them, there is no reason why they should be adopted. The kinetic steam-jet air pump which we have described is claimed to give results at least equal to those obtained with other arrangements and to be extremely simple and reliable. The results of a dry air test on a two-stage Allen kinetic steam jet air pump are given in Fig. 7, whilst Fig. 8 gives the results of tests made on a similar ejector used in conjunction with a 10,000-kilowatt turbo-generator set. It will be noted that the fall in vacuum due to opening an 8 mm. diameter air leakage hole when the turbine is giving an output of 8500 kilowatts, is only ¾in., the additional air leakage being about 90 lb. per hour. The test to which Fig. 8 relates was carried out with the plant in commercial operation.

The condensate is withdrawn from the condenser by a rotary extraction pump, which is shown in Fig. 11. These pumps consist of a two-stage extraction pump and a single-stage kinetic pump mounted on the same spindle, and the latter pump provides the water under pressure for operating the water ejector shown in Fig. 6. All the pumps were manufactured by Messrs. Allen, who assert that their long experience in work of this kind has led them to adopt the two-stage "head and pressure" type of extraction pump, which is considered to be the most satisfactory. This type of pump, the makers explain, presents several distinct advantages over the single-stage type, although it is naturally somewhat more expensive to manufacture. One of the principal advantages of the two-stage type of pump

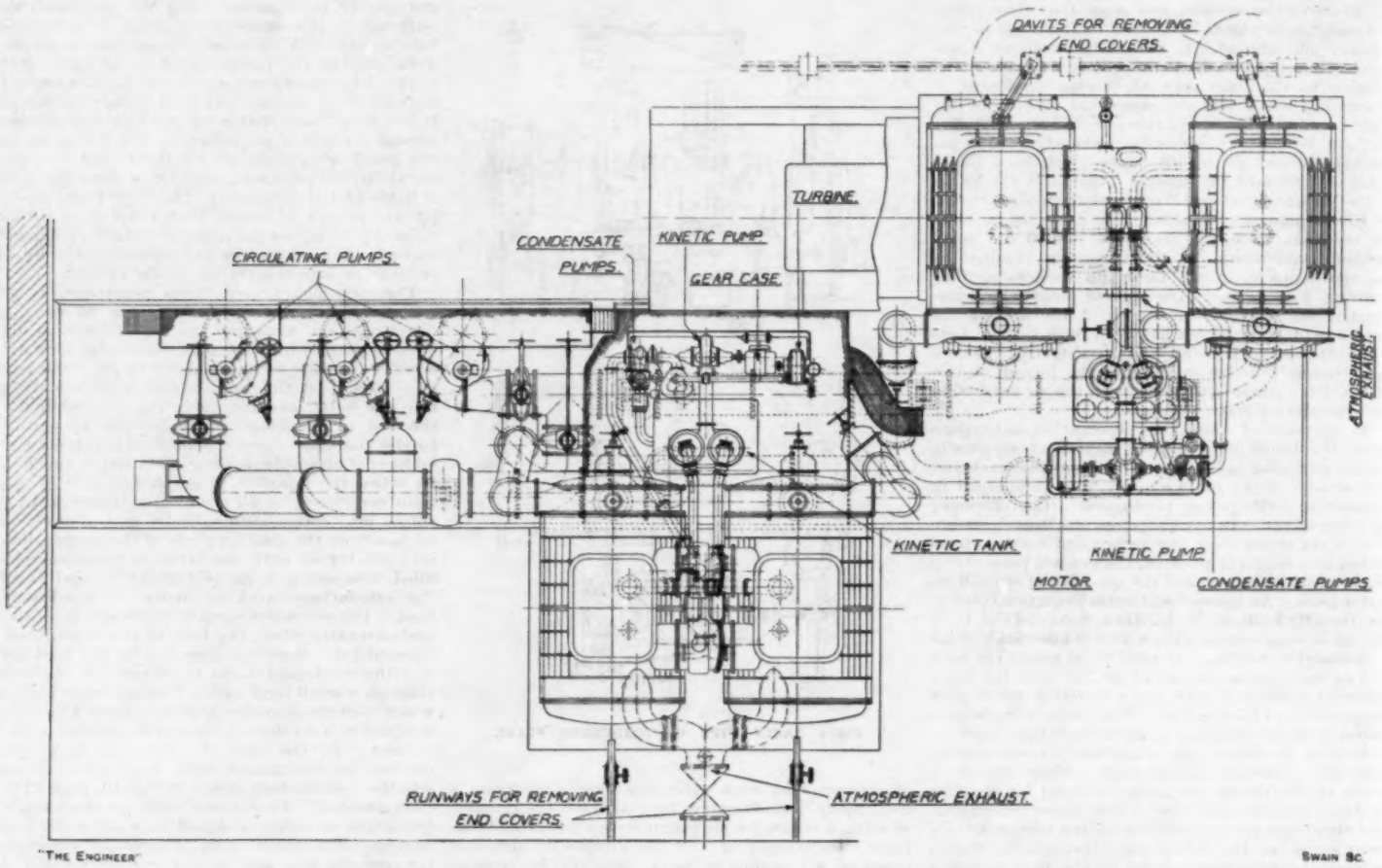


FIG. 3—PLAN OF CONDENSING PLANT AT LOTS-ROAD POWER STATION

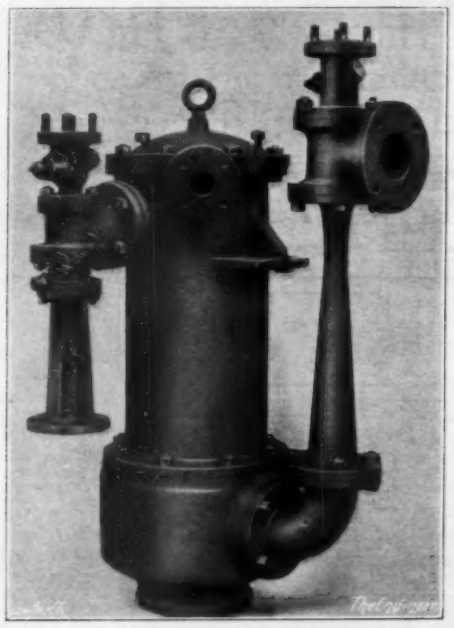


FIG. 4—STEAM-JET AIR PUMP

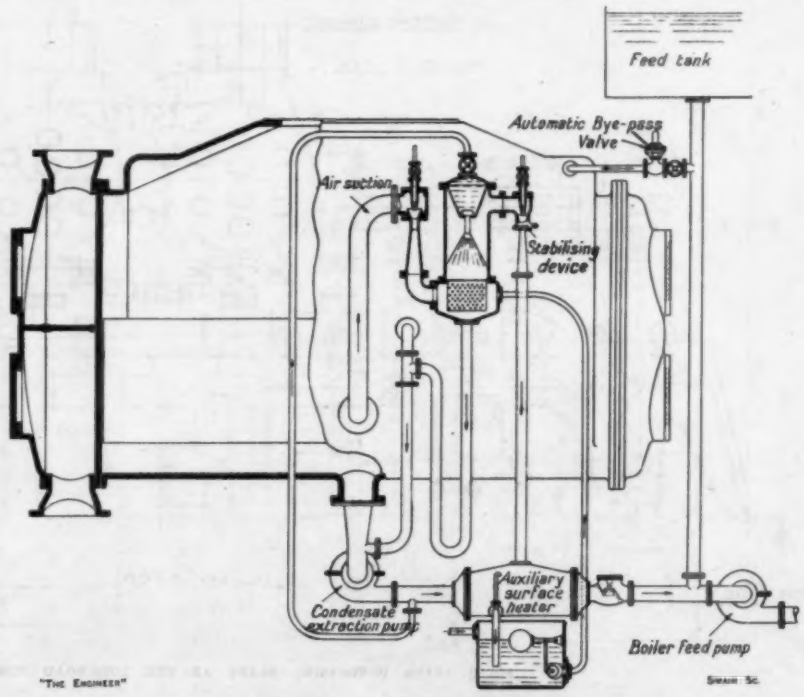


FIG. 5—ARRANGEMENT OF ALLEN STEAM-JET AIR PUMP

is that it makes it possible to reduce the head on the suction side by something like 50 per cent. of that required by the single-stage type. Further, the two-stage "head and pressure" pump is more silent than the single-stage pump, and as the delivery side of the first stage is connected to the condenser vacuum space any air carried into the pump is disposed of and corrosion is said to be unknown. Another advantage of the pump is that it gives a uniform delivery. As will be seen from Fig. 11 the pumps are motor driven, and they run at a speed of 1450 revolutions per minute and have a condensate capacity of 375 gallons per minute. Of late years there has been a distinct tendency to run power station auxiliaries with small steam turbines, and although this practice does not at first sight appear an advance in the direction of economy, it is nevertheless found that if the possibility of heating the feed water with the exhaust steam is taken into account a high overall efficiency can be secured.

A turbine driven circulating pump of the "Conqueror" type is illustrated in Fig. 12. The pump runs at a speed of 950 revolutions per minute when delivering 6000 gallons per minute against a head of 50ft. It is driven by a steam turbine of the impulse type running at 5750 revolutions per minute, and it drives the pumps through a set of double helical reduction gear. All the turbine bearings are lubricated with oil under pressure and a Michell thrust takes up any unbalanced thrust from the turbine or gearing. Emergency cut-out and speed regulating governors are fitted, the latter working the steam throttle valve through an oil relay. The glands are arranged to work with a back pressure or with the full condenser vacuum. The turbine drive is also used for the extraction and kinetic pumps. Fig. 13 illustrates a set of these pumps, which are directly driven from an impulse turbine running at 2000 revolutions per minute and designed to work in conjunction with a 1000-kilowatt turbo-generator set.

In large power stations it is becoming usual to retain the many advantages of electric driving for the auxiliaries without running the risk of a breakdown from overloads or short circuits on the distribution system, a small turbo-generator being installed to provide power for the station itself. This set is usually designed to exhaust either into a condenser or through a closed exhaust range to a feed heater. This arrangement is particularly convenient for starting up in stations which are liable to be completely closed down for short periods, as it provides power for any of the motor driven auxiliaries when re-starting. The whole of the exhaust from this set can be utilised for heating the feed water when the station is on full load Sets of this kind are being built by Messrs. Allen.

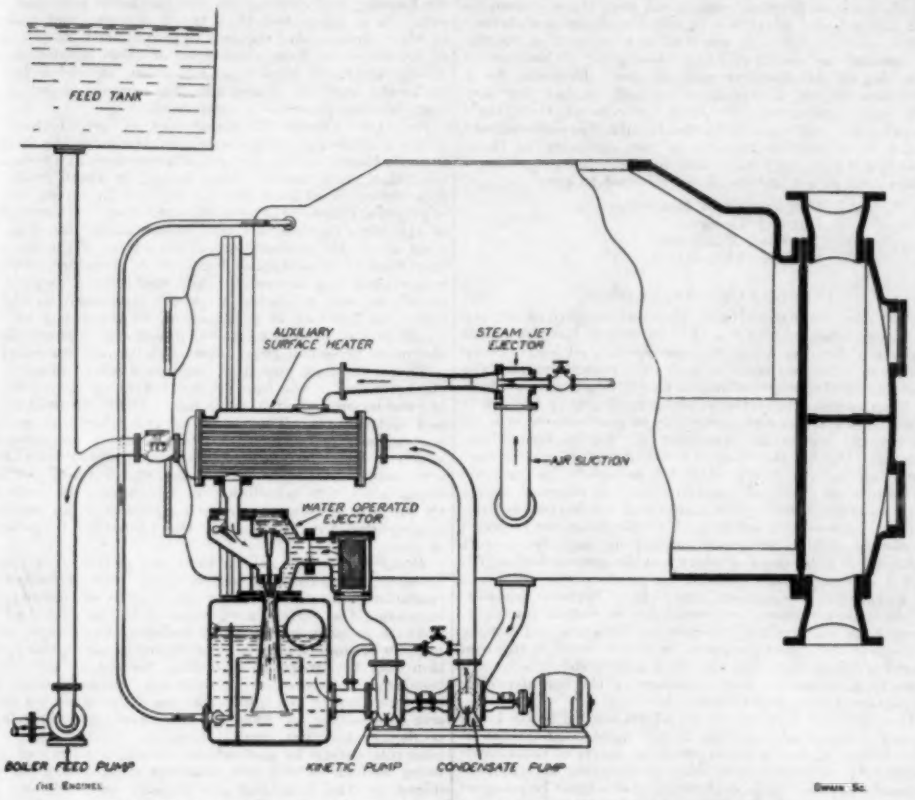


FIG. 6—ARRANGEMENT OF ALLEN KINETIC ROTARY AIR PUMP CONDENSING PLANT

The installation shown in Fig. 10 is used in conjunction with a 10,000-kilowatt turbo-generator set. The main condenser has a cooling surface of 15,500 square feet, and is capable of maintaining a vacuum of 29in. with the barometer at 30in. when supplied with circulating water at 55 deg. Fah., the overall steam consumption of the ejectors being less than 1.3 per cent. of the total feed when the plant is running on full duty, in spite of the fact that the ejectors have been designed with a view to dealing with an exceptionally large air leakage. In connection with this plant a special arrangement has been installed with the object of more completely protecting the boilers from corrosion and incrustation. It can be shown that a large proportion of the impurities found in water and generally considered corrosive are actually only harmful in the presence of free oxygen, and that the problem of prevention of corrosion resolves itself into delivering the water into the boiler in a slightly alkaline state and free from oxygen. Water in free contact with the atmosphere at a temperature of 60 deg. Fah. usually contains about six parts of oxygen by volume for each thousand parts of water, and when heated to boiling point in the atmosphere, the proportion is reduced to about two parts per thousand. In order to eliminate this remaining portion, the water is raised to the highest temperature convenient under the working conditions of the power station, and after separating out as much air as possible by mechanical means it is passed through a de-gasser consisting of a series of compartments packed with finely divided steel, which has been specially prepared both as regards chemical composition and physical condition, and rendered extremely readily oxidisable. It is claimed that after passing through this vessel there is no residue of oxygen contained in the water which is capable of adversely affecting any boilers or pipe connections. If the water were simply passed through a vessel containing oxidisable material, there would be a rapid deterioration in the activity of the material owing to the formation of an impermeable oxide which protects the material and renders the process too slow to be satisfactory. A method of working is therefore adopted whereby layers of the material are allowed a period of rest under which conditions the outer film of oxide undergoes a further chemical change and becomes easily detachable. This oxide is detached from the metal by causing turbulence in the vessel by means of a steam jet and is removed by passing the water through a filter. It would seem that the above process might involve the consumption of a large quantity of this readily oxidisable steel, but for make-up water containing the usual proportion of oxygen, the consumption would be at the rate of 1 ton of material for 100,000 tons of water, and for condensate water returned in a closed system as described above about one-tenth of a ton for 100,000 tons of water.

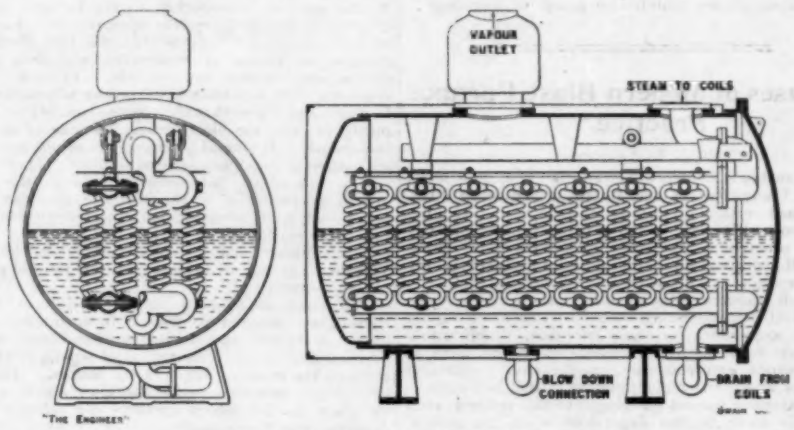


FIG. 9—EVAPORATOR FOR LARGE BOILER PLANT

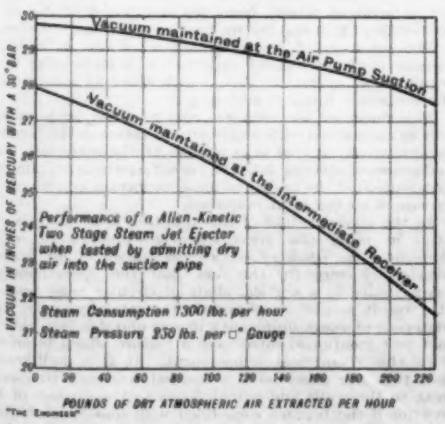

Vacuum maintained at the Air Pump Suction
Vacuum maintained at the Intermediate Receiver
Performance of a Allen-Kinetic Two Stage Steam Jet Ejector when tested by admitting dry air into the suction pipe
Steam Consumption 1300 lbs. per hour
Steam Pressure 230 lbs. per □" Gauge
VACUUM IN INCHES OF MERCURY WITH A 30" BAR
POUNDS OF DRY ATMOSPHERIC AIR EXTRACTED PER HOUR
"THE ENGINEER"

FIG. 7—DRY AIR TEST CURVES

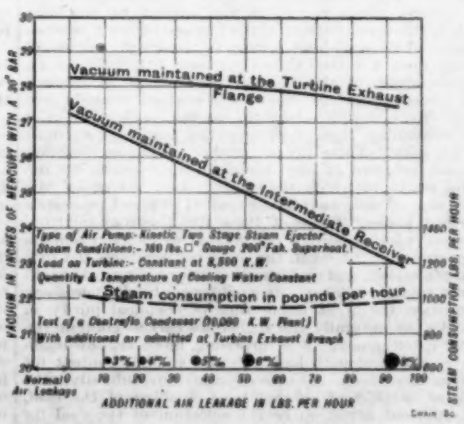

Vacuum maintained at the Turbine Exhaust Flange
Vacuum maintained at the Intermediate Receiver
Type of Air Pump:-Kinetic Two Stage Steam Ejector
Steam Conditions:- 160 lbs.□" Gauge 700° Fah. Superheat
Load on Turbine:- Constant at 8,500 K.W.
Quantity & Temperature of Cooling Water Constant
Steam consumption in pounds per hour
Test of a Electrafio Condenser (10,000 K.W. Plant)
With additional air admitted at Turbine Exhaust Branch
Normal Air Leakage
VACUUM IN INCHES OF MERCURY WITH A 30" BAR
STEAM CONSUMPTION LBS. PER HOUR
ADDITIONAL AIR LEAKAGE IN LBS. PER HOUR

FIG. 8—COMMERCIAL TEST CURVES

tion is kept as high as possible, but this limits the maximum output of the boiler under peak load conditions. The use of evaporated water eliminates all solids from the make-up feed, and this feature eliminates the loss arising from the boiler blow-down. It also allows the boilers to be worked at a very much increased rate of evaporation to meet the peak load conditions. Therefore, in many existing power stations, if the automatic stokers are suitably designed, the use of evaporators would, it is contended, allow a considerable reduction in the number of boilers under steam for any given peak load condition. The practical elimination of boiler blow-down greatly reduces the quantity of make-up feed water required for operating a power station. In a power station requiring from 5 to 6 per cent. make-up, when using softened water, the quantity required when using evaporated make-up would be from 3 to 4 per cent.

In many power stations town water is purchased at considerable expense, and has then to be softened before use in the boilers, whereas a very inferior water, often obtainable without expense, can be evaporated and pure distilled water supplied to the boilers. Evaporation may be effected in single, double or triple effect, the amount of boiler steam required being respectively approximately 1.2, 0.7 and 0.45 times the water evaporated. In each case at least 95 per cent. of the total heat in the steam used can be returned to the boilers in the main feed water. For a make-up of 5 per cent. the feed heating due to the heat available from the evaporators amounts to about 60 deg., 35 deg. and 22 deg. Fah. for single, double and triple effect respectively, and in many stations this heating will allow of bleeder and other heaters being eliminated either entirely or in part. In a triple effect evaporating system, the first stage would be supplied with saturated steam at boiler pressure and the condensation of vapour from the last stage is effected in an evaporator heater through which the main feed water is passed. For 5 per cent. make-up, the amount of live steam required is approximately 2.2 per cent. of the boiler output, and with the heat returned will require only approximately one-tenth per cent. of the fuel used in the station, whereas the saving due to reduction of blow-down, scaling and improved boiler efficiency may easily amount to 5 per cent. on the fuel bill. The type of evaporator recommended for large plants is that shown in section in Fig. 9, but for single unit plants in which the feed make-up is of small quantity, a vertical type of evaporator may be employed. The arrangement adopted will, to a very great extent, depend in each particular case on the circumstances under which the plant is working.

The Bases of Modern Blast-Furnace Practice.*

By A. K. REESE.

In the author's evidence before the Iron and Steel Industries Committee of the Board of Trade in 1918, he mentioned certain important features as constituting the difference between modern blast-furnace practice and such practice as is generally prevalent in Great Britain. He proposes in this paper to elucidate the reasons for those observations by outlining the bases upon which modern blast-furnace practice has been built up, and demonstrating wherein those bases supply the logical arguments for their adoption, which would lead to very desirable improvements in results, both as respects output and economy, in pig iron production in localities where the older practice is still in vogue.

There are many factors entering into this subject, each of which is more or less dependent upon the others. They may be divided under four major headings, which may be called the prime factors in modern blast-furnace practice.

Before discussing these prime factors in detail, it might be as well to consider the objects which modern blast-furnace practice seeks to obtain. That practice is distinctly the result of evolutionary progress, the modern phase dating from 1894, when James Gayley introduced the low bosh at Braddock, Pa.—up to the present, the era of the large hearth diameter and steep bosh angle.

There are three principal objects in all blast-furnace practice ranking in importance in the following order—quality, economy, and quantity. The first is essential. The second is commercially of great importance. The third is highly desirable, particularly in its bearing upon the second. No. 1 may be obtained independently of the other two. No. 2 may be obtained, to a degree, independently of No. 3. No. 3 is, to a degree, subject to Nos. 1 and 2. In all blast-furnaces one of these objects has been the limiting factor in the attainment of the others.

The object sought through the application of so-called modern practice may be described thus:

> Consistent with quality to produce the greatest possible economical quantity, and as any material increase in quantity has a direct and favourable bearing upon economy this description of the object of modern blast-furnace practice may be condensed to—*the attainment of the greatest possible quantity consistent with quality.*

The degrees to which this object has been attained in certain localities, in comparatively recent years, resulting in normal economical outputs of from 400 tons to 600 tons per twenty-four hours, is well known, and demonstrates the great commercial advantage to be obtained by the adoption of the principles and methods by which it has been attained, in those other localities which up to the present have not yet fully adopted them.

* Iron and Steel Institute. York Meeting, 1922.

There may be, and doubtless are, some makers who are still of opinion that with their particular materials the principles and methods of so called modern blast-furnace practice are not applicable. It is with the hope of convincing them, and of strengthening the growing belief of others, that the author has undertaken this paper, for it is his firm conviction that those principles and methods are adaptable to any iron-bearing materials which are workable in a blast-furnace, subject, of course, to suitable fuel and flux being obtainable within even a wide degree of quality, and subject, likewise, to a minimum degree of variation in that quality for any individual operation. He feels convinced that their adoption will lead to so great an advantage as to constitute almost a revolution in the pig iron industry in those localities where they have not hitherto been applied.

The four prime factors above referred to are:

I. Preparation of Materials.
II. Furnace Design.
III. Auxiliary Equipment.
IV. Method of Operation.

I. Preparation of Materials.

That the mechanical and physical conditions of the materials charged into a blast-furnace have a most important bearing upon its successful and satisfactory operation, affecting both its operative conditions and the economy of the results obtained therefrom, is a fact which no blast-furnace operator is likely to dispute; but while it is true of any blast-furnace it is particularly true in its bearing upon the operation of the modern blast-furnace. One of the essential conditions of satisfactory operation is that there shall be as nearly as possible uniformity of chemical reactions, and of physical movement of the materials throughout the whole cross-section in every zone of the furnace. Two elements are required to obtain this in theoretic perfection, namely, perfect uniformity in the size and density of the materials charged, and a sufficient blast volume to produce the condition of a plenum throughout the whole furnace interior. While it is, of course, impracticable to obtain for blast-furnace use materials of perfectly uniform size and density in each of the three classes of materials used in pig iron smelting—fuel, flux, and ore—it is practicable to approximate to a degree to that condition by the use of proper means for their preparation.

It is obvious that the future which most directly bears upon the essential condition above mentioned is that of distribution, and in order to obtain as nearly as practicable uniformity of distribution such preparation as will give as nearly as practicable uniformity of size must be resorted to. For reasons which will be referred to later, uniformity of size only is not, however, sufficient, for example, uniformly large size, while giving uniformity of distribution, would be detrimental to economical operation. The preparation of materials must be in the direction of uniformly small size.

Fuel (Coke).—While this principle is much more important in its application to the ore and flux than to the fuel, it also applies, to a degree, to the latter. As rapidity of action is largely dependent upon rapidity of combustion of the fuel, it is desirable that the fuel should not be charged in lumps of excessive size, and preferably should not exceed 4in. to 6in. This is, of course, assuming that the coke is of proper physical condition. It may be said here that the physical quality and chemical purity of coke for blast-furnace use are of the greatest importance. It should be strong but of not great density, and as low as possible in ash and sulphur. There is nothing which more greatly interferes with the regular and economical operation of a blast-furnace than soft, friable, or high ash coke, as everyone connected with the industry has experienced during late years under the conditions existing during, and for some time after, the late war. The disadvantage of high sulphur in the coke need not be emphasised.

The coke as charged into the furnace should be thoroughly screened to free it from smalls, commonly known as breeze, and should be of sufficient strength to prevent the excessive formation of smalls in the furnace through the crushing effect of the burden. The strength should not, however, be of the kind which is produced by great density which destroys the cellular structure. A dense coke burns slowly, and is, therefore, inimical to rapid combustion, which is necessary for fast driving, whereas cellular structure permits the heat and the agents of combustion to penetrate readily to the interior of the lumps, thus facilitating combustion. On the other hand, a very open cellular structure produced at the expense of strength is equally to be avoided as tending to produce smalls through its lack of resistance to crushing by the weight it has to bear, and abrasion by its movement in the furnace. Such a fuel is also subject to excessive waste in the upper regions of the furnace before it reaches the zone of its usefulness, owing to the greatly increased reaction upon it of the CO_2 in the gases—$CO_2 + C = 2CO$. It is, therefore, of the greatest importance, in modern blast-furnace practice, that coke-makers should give the greatest possible attention to the production of a coke combining these two essential features—strength and porosity. There are a number of factors entering into this problem of blast-furnace coke making, by the careful study of which the makers may arrive at the production of coke having the desired physical properties described above. Some of these are the coal mixture, the mechanical condition of the coal as charged and its compactness in the oven, the oven temperature, the rate of carbonisation, and uniformity of coking action throughout the coking chamber. It would seem hardly necessary to mention the great importance of chemical purity in the coke, as naturally the higher its carbon content the greater its efficiency. It is surprising, however, how much coke is produced with high ash and sulphur content for blast-furnace use; in many cases, undoubtedly, the result of insufficient or inefficient washing of the coal, or insufficient attention to the selection of the coal for the production of blast-furnace coke. Care in selection and efficient washing of coal for coke production are, therefore, of very great importance in their bearing upon economical blast-furnace operations, and every possible effort should be made by blast-furnace owners to induce coke-makers to meet their requirements as to mechanical, physical, and chemical quality. It is the carbon which does the work in the furnace, and every decrease in the percentage of ash increases the available carbon and tends in other ways towards a higher degree of efficiency. In addition to the higher fuel value of low ash coke, it is lighter in weight, requires less limestone for fluxing the ash, and a lower amount of the fuel charged is required for forming and melting the slag produced from the coke ash. It is estimated that the formation and melting of blast-furnace slag requires approximately 25 per cent. of its weight in fuel; therefore, for every hundredweight of slag produced from coke ash ¼ cwt. of fuel is lost so far as the smelting of iron ore—the primary object of the blast-furnace process—is concerned.

Iron Ore.—From the standpoint of preparation, the iron ore is the most important of all the materials charged into the blast-furnace, owing to the extremes in mechanical condition, from fines to large lumps, in which most iron ores are received from the mines, and the great variety of physical characteristics in different ores. The operation of the blast-furnace is much more usually affected, for good or ill, by the mechanical condition of the iron ore than that of either fuel or flux. It is, therefore, of prime importance that this condition should receive very careful attention, and whatever steps are necessary should be taken, in the way of preparation, to convert it to that condition—or as near to it as is practicable—as will insure the most beneficial effect upon the furnace operation.

There are two principal features directly affected by the condition of the iron ore, both bearing upon the rate of production and upon economy. These are reducibility and distribution. The degree of reducibility of an iron ore depends primarily upon its density, a characteristic which in itself is not readily altered, except with dense ores containing high percentages of protoxide of iron (magnetite), the reducibility of which may be increased by subjecting them to a roasting process in an oxidising atmosphere, thus converting the protoxide to peroxide of iron.

Rough Ores.—The rate of reduction in the furnace may, however, be materially increased for any particular ore containing lumps, whatever its degree of density, by increasing the surface area exposed to the action of the increase in surface area is by breaking the lumps into a number of smaller pieces. The extent to which this operation may be carried is, of course, limited by the cost of breaking the ore—a commercial consideration—and the tendency of any particular ore to produce an excessive proportion of fines in the breaking. The latter tendency, however, really does not exist to any considerable extent in ores whose condition allows of their being broken at all, for whatever smalls may be produced in the breaking are usually of sufficient size not to be classed as fines, and may, therefore, be safely charged into the furnace with the larger products of the breaking operation.

The increase in the rate of reduction obtained by thus increasing the surface area exposed to the agents of reduction in the furnace, has, in addition to the higher possible rate of production, a very important effect upon economy of production. There are two principal reducing agents in the blast-furnace process, carbonic oxide and solid carbon, and it is generally accepted that reduction of iron oxide by carbonic oxide, in the upper zones, is a much more economical reaction than the reduction of iron oxide by solid carbon in the lower zones. It is, therefore, highly desirable that the whole or the greatest possible portion of the iron oxide should be reduced by carbonic oxide gas, and that this reduction should be completed before any lumps of iron oxide have reached the zone where conditions permit, in excess, the uneconomical reaction between them and solid carbon. It is obvious that the surest way of attaining this is to so increase the possible rate of reduction of the ore by increasing its surface area, as described above, that the maximum reduction may be effected by the carbonic oxide gas in the upper zones of the furnace. If this precaution of increasing the surface area by breaking the lumps of ore before charging into the furnace is neglected, the larger unbroken lumps will escape thorough reduction by carbonic oxide gas with consequent waste of fuel, particularly if any attempt be made to increase materially the rate of production by rapid driving. To obtain a high rate of production, with economy and quality, it is therefore necessary to prepare the ores in the manner described.

The degree to which it is commercially practicable to crush an ore depends upon its density. Experience has indicated that all ores should be crushed to sizes not exceeding such as will pass through a 3in. or 4in. ring, although ores of great density may be advantageously crushed to even smaller sizes. The standard of 3in. or 4in., while seemingly rather small for ores of a high degree of reducibility—the so-called "soft" ores—is not determined wholly from the standpoint of degree of reducibility, but also by its bearing upon distribution.

The question of the distribution of ore in a blast-furnace is of the highest importance in its bearing upon regularity of operation, this in turn affecting most vitally the economy, quality, and output.

This question has been referred to above in a general way in connection with uniformity of action in the furnace, but important as that is as regards all the materials, solid and gaseous, entering into the blast-furnace operation, the distribution of the ore is the most important consideration in regard to the solid materials.

In the consideration of this question it is necessary to keep in mind the great essential—*equality of action throughout the whole of every cross section of the furnace interior.* Except for the fact that the operations are taking place in a vertical shaft of circular cross section, this result would be obtained, theoretically, only with materials of exact uniformity in size and density, but the fact just mentioned introduces a feature which interferes with this theoretical requirement. It is a well-known fact that the gases have a natural tendency to ascend next to the walls and would do so to the neglect of the interior if the furnace were filled with materials of exact uniformity in size and density. It is necessary, therefore, in order to secure approximate equality of action, to have a somewhat greater resistance to the passage of the gases in the materials nearest the walls than in the interior. It is to this condition that the ordinary bell and hopper charging apparatus owes its satisfactory use, discharging the materials as it does in such a way that a greater

proportion of the smaller particles remains next to the walls, thus providing the somewhat greater resistance to the ascending gases required there. In order that this distribution by bell and hopper charging may give the desired result the relation of the diameter of the bell to the diameter of the furnace throat at the stock line is of material importance, as likewise that the falling materials shall first strike the materials in the furnace, when nearly full, at about 18in. from the walls. The former relation is usually a bell diameter 4ft. to 5ft. less than the throat diameter at the stock line. The bell angle is usually 40 deg. to 45 deg., and in some cases 50 deg.

This method of charging results in the surface of the material in the furnace assuming the shape of an inverted cone with its base about 18in. from the walls, from which point they slope away slightly to the surface of the walls. The smallest particles lie on the base of the cone, and between it and the walls, together with a portion of the smaller lumps and rubble. The inner slope from the base to the apex of the cone consists of pieces of gradually increasing size with practically only the largest lumps at and near the apex. This description does not, of course, apply to an ore mixture consisting of all fines, or of lumps of uniform size, conditions which very seldom exist in blast-furnace practice, but it does apply to the usual run of ores which consist of a mixture of fines, rubble, and lumps.

It is obvious that the greater the difference between the largest and the smallest pieces, or, in other words, the larger the lumps the greater the sorting action above described, and conversely, the smaller the maximum size of the lumps the less the degree of segregation. It is, therefore, further obvious that to avoid excessive segregation, the preparation of the ore by crushing the lumps to smaller, say rubble, size is necessary. The crushing of the lumps prevents excessive segregation in two ways, first, being smaller, they have less tendency to roll down the sides of the inverted cone to the apex, and, secondly, the broken pieces have usually sharp and jagged edges, and have, therefore, a greater tendency to lodge nearer where they fall, and the movement of the materials to the centre is more likely to be *en masse*, carrying a certain amount of smalls with it. It is thus that preparation by crushing materially improves distribution by preventing excessive segregation, which is a condition directly inimical to the application of modern blast-furnace practice.

In the distribution existing when the usual run of ores and limestone are charged "as received," there is, as described above, a core, or column in the centre of the furnace consisting almost entirely of the largest lumps, the area of the cross section of this core varying with the size and proportion of lumps to rubble and fines. Between this core and the walls there is an annular ring consisting of a mixture of rubble and smalls, in which the proportion of rubble to smalls gradually decreases until, next to the walls, there are practically only smalls and fines. As previously pointed out, an essential to regular and economical descent of the materials is perfect uniformity of action of the ascending gases upon the whole of every cross-section of the material in the furnace, and while this is an ideal condition which may be impossible of full attainment in actual practice, the nearest possible approach to it is of the greatest importance. There can be very little approach to such a condition if the ascending gases are forced, under pressure, through a mass of materials distributed as just described. Very little, if any, of the gases will find contact with the closely packed fine materials close to the walls, and the greater proportion will pass up through the more open structure in the centre, the core of large lumps, and a proportion only through the annular ring of rubble and smalls. The result of this unequal distribution of the ascending gases is the faster descent of the largest lumps in the centre, and a gradually slower descent of the outlying materials. Such a descending movement of the materials of the various sizes is exactly contrary to what is most desirable. Those which descend most rapidly, owing to their slower rate of reducibility should descend most slowly, and those which descend most slowly, owing to their high rate of reducibility should descend most rapidly. Maximum economy and output are impossible under such conditions, for, apart from the question of irregularity of movement which almost always results from them—see below—it is necessary to provide an excess of fuel to insure the complete reduction of the more rapidly descending lumps before they enter the melting zone—see above, under Reducibility—and the rate of driving is limited by their slower rate of reducibility. Any attempt at really fast driving under these conditions so reduces the ratio of ore to fuel which can be carried that not only is the output not increased, but the fuel consumption is very greatly increased, with the added danger of the production of low grade iron through unreduced ore entering the furnace hearth from over driving, or irregular descent of the materials.

Under the conditions existing in a furnace charged in the manner under consideration, there is always a strong tendency towards irregularity of movement, or none at all, in the material nearest the walls, with a gradual building up on the walls. This building up continues until portions either become permanently stationary, forming scaffolds, or masses break away and are precipitated towards the centre and into the actively descending materials and rapidly ascending gases, constituting the well-known slip. This procedure is more or less frequent and more or less severe, from the small slip, causing temporary production of off grade iron, to the heavy slip or explosion, which either blows off the furnace top, or fills the tuyeres with slag, chills the hearth, "gobbs up" the furnace and puts it out of commission for days, an evil too well known among those who may be interested in this paper to require any emphasis; but to whatever degree it occurs it very seriously interferes with the regularity which is essential to the best results. The disadvantages from the accumulated effects of these conditions are only avoided, and even then not always satisfactorily, by periodical partial clearance of the furnace walls by the use, temporarily, of considerably reduced burdens, or, which is the same thing, by charging extra fuel, at the expense of both economy and output. These evils can only be avoided by the proper preparation of lumpy ores by crushing.

Fine Ores.—The disturbing effects upon blast-furnace operations of the use of any considerable proportion of very fine ores—exaggerating the conditions described under Distribution—are too well known to require special emphasis. Although in modern practice furnace design and method of operation have considerably reduced these effects, such ores are still sufficiently objectionable in this respect to make advisable some treatment to change their character as fines. In this case the process of preparation is the reverse of that for lumpy ores, that is, instead of reducing, it is desirable to increase their size, in order to remove their clogging effect in the furnace, and to prevent their being carried out in excessive quantities, by the escaping gases, into the gas flues.

Various processes have been introduced for this purpose, such as briquetting, nodulising, and sintering, each of which yields a satisfactory product for use in the blast-furnace. Sintering is the more recent process, and has grown very rapidly in favour, owing to its lower production costs, and the large range of materials which may be treated by it, including blast-furnace flue-dust, the recovery of which alone in some cases warrants the installation of the process, particularly as, in addition to the iron ore recovered, the dust usually carries such an excess of fuel over what is required for its own treatment that a considerable proportion of other fine ore, without fuel, may be mixed and sintered with it. By these processes, and particularly sintering, many ores which, in their natural state, are unsuitable for use in the blast-furnace, either owing to their mechanical condition, or high sulphur content, or both, may be rendered suitable.

The Flux (*Limestone or Dolomite*).—Of the solid materials, the flux, being easily acted upon by the heat and chemical reactions, and usually forming a small proportion of the mixture, is of less importance in connection with the question of preparation of materials. It is of sufficient importance, however, to receive consideration, as its mechanical condition has a definite bearing both upon distribution and rapidity of action in their bearing on economy. Although the effect is less in degree, it is the same in principle as in the case of the ore, and for similar reasons the flux should be broken to as nearly as practicable uniform size. In practice it has been found sufficient to break it to sizes not exceeding 4in. or 6in., or such as would pass through a 4in. or 6in. ring, although there is no disadvantage in breaking it to even smaller sizes. The author has had personal experience with large blast-furnaces using oyster shells alone as flux over a considerable period with perfectly satisfactory results, except that there was added to the waste gases a further objectionable feature to their usual asphyxiating qualities, their bad odour.

Blast.—The only remaining "raw material" essentially used in blast-furnace operation is the air which supplies the oxygen necessary for the combustion of the fuel.

There is little to be said with regard to the blast under the heading of Preparation of Materials, that is, in its bearing upon modern blast-furnace practice as distinguished from practice which is not "modern," except that the usual custom in the latter is to take the air as we find it, although not always in all its purity. Too little attention is usually paid to this point. Natural air in its purest state has its detrimental constituents, but as a rule little attempt is made to draw the supply for the blowing-engines even as pure as it occurs. The proximity of boilers and free exhaust auxiliary machinery, and various sources of evaporation, too often charge the air near blast-engine houses with quantities of moisture much in excess of that in natural air "in its purest state." In modern practice practically all exhaust steam is condensed, and a large proportion of the auxiliary machinery is electrically driven. There is, therefore, little, if any, opportunity for extraneous moisture to enter the blast-engines with natural air. This is a feature of considerable importance, and has an appreciable bearing upon the economy of modern practice.

Although in view of its lack of more general adoption it has no direct bearing upon the subject of this paper, there is a treatment to which natural air may be subjected for its improvement for blast-furnace purposes, which comes logically under the heading of Preparation of Materials. As a strong advocate of this treatment the author hopes that a discussion of it at this point will not be considered out of place. This is the question of dry blast, or, to be more exact, the treatment of natural air for reducing its hygroscopic moisture to a uniform and low content—a treatment first introduced and practically demonstrated by James Gayley in 1904.

There has been a great deal of discussion, and even contention—mainly theoretical—as to the merits of this process. At the time of its introduction a great stir was caused in iron-producing centres, and during the following years a considerable number of plants were installed for its use in the United States more particularly, and in Europe. Some of these installations are still used continuously, and some are used intermittently in the United States, that is, they are used in the summer months when the moisture content of the air is high, and discontinued in the winter months when the moisture is naturally low. In other cases their use has been entirely discontinued.

There is, however, practically unanimous agreement amongst those who have used "dry blast" that its use does improve blast-furnace results, although opinions differ as to the degree of the economy. The author has had an opportunity during the past eighteen months of discussing this matter with representative American blast-furnace operators, particularly as to the reasons why the process has not been more generally adopted and its use continued more generally where plants have been installed. The explanation given is that the benefits obtainable from "dry blast" have been superseded by the great advance in blast-furnace results brought about in recent years by improvements in furnace design, and the altered practice following those improvements. In other words, it has been possible to obtain, in other ways, advantages equal to those derivable from "dry blast" under the older practice. It may be a very bold thing for the author to say in the face of these opinions, but he believes that attitude to be a mistaken one, and that if every advantage which can be derived from "dry blast" is provided for, further improved results are obtainable in addition to those already obtained by the means above referred to.

The author has had considerable experience with "dry blast," having used it continuously on two large furnaces during the past thirteen years with such satisfactory results that he would have considered its abandonment a very serious step in the wrong direction. It is not his intention to enter here into a discussion upon the advantages of "dry blast" in detail or in general, but there is one very important feature in connection with its use which seems to have been missed by those who have used and abandoned it, either partially or wholly, a feature which, in all probability, explains the attitude adopted towards it in the United States in conjunction with later American practice, and possibly elsewhere. This is the important factor of blast temperature. It is the author's experience, and he believes it is also general experience—although there may be isolated cases to the contrary—that with natural air there is an upper limit to the temperature of the blast which can be used with satisfactory and smooth working for any particular furnace. Any considerable increase beyond this limit causes "stickiness," "hanging," and irregular movement of the materials in the furnace. In his discussions with American blast-furnacemen he was told that this was the case even with furnaces of the latest design, and a particular case was cited at one of the most modern plants in America, where very high temperatures of blast were tried with results as above mentioned. The blast temperatures generally used range from 1150 deg. to 1250 deg. Fah., while with clean gas and modern stove design—and sufficient stove capacity—temperatures as high as 1500 deg. to 1600 deg. Fah. are obtainable.

The economical advantage which could be derived were it possible to make satisfactory use of this additional heat in the blast, need hardly be emphasised, and any practical means which would render this possible would confer a very important boon upon the iron-producing industry. The author's experience is that such a means is available in "dry blast," and that it is this further advantage of dry blast added to those which are already conceded it, which would, if taken advantage of, settle the doubts of those who are still undecided, and convert those who have already condemned it. It may be said that he was in a fortunate position to have available such high temperatures—he has used temperatures as high as 1600 deg. Fah., normally from 1450 deg. to 1550 deg. Fah., temperatures under 1400 deg. Fah. being considered too low—but what was available to him is obtainable by others, and he would emphasise the fact that without dry blast, although available, he could not have used them.

(To be continued.)

Manchester Association of Engineers

The opening meeting of the Manchester Association of Engineers was held at the Memorial Hall, Manchester, on Friday last, and was very well attended. Before delivering his inaugural address, Mr. Daniel Adamson, M.I. Mech. E., presented Constantine Gold Medals for papers read during the last session to Mr. William Fox, M.I. Mech. E., M. Inst. N.A. (member), for his paper entitled "Some Engineering Developments on the Manchester Ship Canal," and Mr. Harold F. Massey, B.Sc., M.I. Mech. E. (member), for his paper entitled "The Flow of Metal during Forging." The Butterworth Gold Medal for contributions to the discussions during the past session was awarded to Mr. George E. Bailey, M.I. Mech. E. (member).

The presidential address covered a wide range of subjects of local and general interest. Mr. Adamson defined engineering as a continuous effort to improve the existing state of affairs, and to maintain this effort the internal change called for by the changes in the product, he said, appear to be more frequent than in other trades, because engineering had to build its own machinery as well as provide tools for others. As an example, the adoption of steel in place of wrought iron meant larger machine tools to produce and handle the resulting larger pieces, as well as larger plant to use the castings and forgings so produced. For instance, up to, say, twenty-five years ago the designing of new machines was not advancing at such a rate that a tool became obsolete in one generation. Planing machines, lathes, drilling machines, and the like were so nearly capable of holding their own after twenty years' service that the advantage of new machinery was not sufficiently appreciable to cause a change. Since then, however, many factors had come into play to alter that state of affairs. Capital had been more readily available for the purchase of more expensive machinery, the all-round skill of the handicraftsman had given place to the more limited experience of the machine tender—owing to the specialisation of operations—while improved lifting appliances and tool steels had enormously increased the possible output per individual. The old-fashioned way of estimating based upon a pound for wages, a pound for material, and a pound for establishment charges and profit was satisfactory enough when labour formed a large proportion of the cost of production in an engineering works, and the capital value of the plant was a negligible item, but now that improvements in machinery had so reduced the net cost of labour and at the same time swelled the capital account, while material was so frequently purchased in a more finished form, the relative figures for labour, materials, and fixed charges bore very different proportions, and the accelerating depreciation of the expensive machinery, better called antiquation or obsolescence, brought in important factors frequently overlooked. The President gave it as his opinion that the explanation of the disappointing commercial results of the engineering trade over a number of years was to be found in the omission to make proper financial provision for these unavoidable changes. Referring to trade association, Mr. Adamson said they could only be justified by the improvement of the quality of the products by their members and by cheapening production. When trade was bad, we heard a great deal about "economic laws" and "labour unrest," but the impression conveyed generally by the use of those terms was very vague and indefinite, and a feeling was left that they were used to cover up difficult points in the discussion. Put in simpler language, bad times for capital meant bad times for labour, which might take the form of labour disputes, unemployment, or reduced hourly wages, while good times meant more regular employment for some time before better dividends were earned for the shareholders.

Electrical Markets of Peru.

A DEMAND has sprung up in Peru for electrical equipment and accessories, the outcome of the wide programme of economic development advocated by the Government. This demand has disclosed the fact that stocks of electrical goods of almost all descriptions have fallen very low, many of the wholesale warehouses being depleted. Since the decision to nationalise water power in the republic was announced, considerable activity has manifested itself with regard to the adaptation of hydraulics for manufacturing as well as for lighting and heating purposes. Further wide developments are confidently anticipated in the immediate future, and even where water power is not available, internal combustion engines are being installed either to operate directly on crude oil, which is found in abundance locally, or on gas manufactured from the oil. Electric motive power is also being gradually applied to sugar mills, of which a large number are crushing all the year round, but which now make use of the bagasse, or cane refuse, to generate steam. Generators driven by steam engines are only to be found, however, where electric plants are put in, whether the installations are for lighting alone or for power and lighting combined.

It is understood that within the next few months considerable orders for electrical machinery, such as motors and generators, will be placed, principally in the larger cities of Lima, Arequipa and Cuzco, apart from the requirements of the mines, textile mills and other power-using industries. Several existing establishments—such as the Cachapoal power plant belonging to the Braden Copper Company, the Empresas Eléctricas Asociados, the Sociedad Eléctrica de Arequipa, and the Oroya hydro-electric plant of the Cerro de Pasco Mining Company—contemplate extensions to their present equipments; while the recent widespread concessions granted to the Robert William Dunsmuir—Canadian—interests and the important contract entered into by the Government with Marconi's Wireless Telegraph Company, Limited, will, it is thought, eventually result in substantial orders for electrical plant, machinery and accessories being placed.

In the smaller towns of the republic, over 40 per cent. of the inhabitants use electric light. With few exceptions, house lighting is furnished by single drop lamps suspended from the ceiling by flexible cords, neither bracket lamps, chandeliers or table lamps having as yet been generally introduced. It is thought that in this direction alone a good opportunity exists for manufacturers who can offer moderately priced wall brackets, clusters and similar fixtures for indirect or semi-indirect lighting. Hitherto, few efforts have been made to introduce any improved system of lighting, but there is little reason to doubt that such efforts would prove successful if persevered in.

Lima, with nearly 17,000 consumers of its own, is the central distributing station for all up-country dealers, who, in turn, sell to the smaller dealers or to the consumer direct. In other centres, such as Cuzco, Huancayo, Casapalca and Junin, where hydro-electric plants have been some time in operation, the sale of fittings and equipment, although small at present, promises development in the near future. As yet, the field for house, warehouse and shop lighting, as well as for municipal lighting and the supply of electric signs, has not been touched; while favourable opportunities for plant and accessories may be found in connection with the larger power-using industries, such as transport—railways and tramways—textiles, breweries, &c. With the exception of some cheap German manufactures, little effort has been made to create a market for medical apparatus, meters, instruments, electric fans and other household and office devices, such as vacuum cleaners, cooking ranges, ironing machines, radiators, &c.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CONCRETE ROADS.

SIR,—In your issue of October 13th appears an excellent article on "Concrete Roads in Manchester," by the city engineer, Mr. Meek. The letter states that:—(*a*) The aggregate used in the wearing surface of the concrete road is ¼in. to ½in. gauge. (*b*) "Ordinary tar spraying has been tried"—on these concrete roads—"but has not been a success in Manchester. One or two special preparations have also been tried, and although superior to ordinary tar spraying, they have not been quite the success that was anticipated."

It may be of interest to your readers to know that concrete roads were laid in 1917–1918 in London with a similar aggregate in the wearing surface, with identically the same results as those stated by Mr. Meek, as regards the inefficient adherence of the tar-spray carpet to the concrete. Asphalt and bitumen carpets were tried with no better results.

I was early convinced that in order to make concrete roads a complete success, it was absolutely essential that some thin strongly adhesive and easily and quickly renewable protective coating should cover the concrete surface to take the wear of the traffic and also to (1) render it less glaring to the eyes in strong sunshine than a plain concrete surface; (2) act as a waterproof coat to prevent the concrete getting wet, with consequent unnecessary alternations of expansion and contraction therein; (3) provide a cushioning buffer between the concrete and horse feet, iron-tired wheels, &c.

Having little or no experience, like everybody else in those days, as to the best wearing surface for concrete roads, I was primarily in favour of making it with small aggregate like a granolithic paved floor or pavement flagging. It was not long before I found I was on the wrong track, for with small aggregate (*a*) the surface under heavy traffic wore unevenly, owing perhaps to varying amounts of laitance or drowned cement brought to the surface by the workmen in working the screeds; (*b*) the heavy iron-tired traffic cracked unprotected ¼in. or ⅜in. aggregate like nuts, and the rubber-tired traffic sucked out the fragments. Whilst the tar carpet used remained in position and did not flake off, the action (*b*) above did not take place.

It was soon obvious that the reason that a tar or asphalt carpet would not successfully adhere to a concrete surface finished off rough or smooth in the ordinary way was on account of the laitance scum left on the concrete when the work was completed. This laitance, though seemingly hard and tough, and binding the exposed surface aggregate together, in reality for months afterwards came off on the fingers when touched, and actually acted as a French chalk powdering to prevent the adhesion of the tar carpet.

I was aware that in East Ham during the war granite-paved road crossings had been coated with a successfully adhering carpet of bitumen compound. These granite setts were polished by the traffic, but carefully cleaned before putting on the carpet, and in this latter fact, it occurred to me, lay the secret of a successful carpet to a concrete road. The idea of small aggregate was abandoned in favour of a large-sized aggregate. In a mile stretch of water-bound macadam road, 30ft. wide, was inserted early in 1920 a concrete road strip, 30ft. wide by 16ft., along the road. This was finished at the surface with 2½in. coating, made up of 1 cement, 1¼ sand to 3 of broken granite aggregate. This surface coat was laid on 8in. of 6 to 1 gravel concrete, whilst the latter was still soft. The broken aggregate of the surface layer was ordinary Guernsey granite road metal of uniform size broken to pass a 2½in. ring. The next day, after laying the concrete, the surface was washed and brooomed to remove the laitance, with the result that each stone, whilst being effectually set, owing to its depth in the concrete slab, stood up a clear ½in. or so from the cement mortar.

In the spring of 1920 the whole mile stretch of road was Tarvia sprayed and sprinkled with granite chippings. By November of that year, the summer of which was comparatively wet, practically the whole of the coating was worn off the water-bound macadam, whilst the coating on the concrete portion was perfect.

In the spring of 1921 the whole of the water-bound macadam portion was tar sprayed and again sprinkled with granite chippings, but the concrete portion—having a perfect carpet—was left untouched. No tar spraying has been done on the road this year, and whilst the water-bound macadam is corrugated and has no tar carpet, the original Tarvia carpet laid on the concrete portion in 1920 is in excellent condition. The Tarvia has none of that brittle appearance common to such coatings laid on water-bound macadam, where each individual stone moves in relation to its neighbours, according to every varying expansion and contraction stresses put on the road crust by constant alterations of temperature and of moisture contents in the crust. An examination with the point of a knife shows that the Tarvia has retained its essential oils, and is as good practically as the day it was put down. Had it not been for the excellent results of the Tarvia coating laid on the concrete in 1920, it might have been concluded from the results obtained from that laid on the water-bound macadam portion at the same time, that the Tarvia was of a very inferior quality.

Where a road is constructed in alternate bays with the intervening bays filled in later, as Mr. Meek advocates, such a carpet is sufficient to span and protect the minute joints between such adjacent bays. In conclusion, I may say:—

(1) That a concrete surface made of aggregate of size ¾in. and downwards could not with any practical success be washed and broomed a few hours after setting without endangering the bedding and future security of such small stones in the concrete mass.

(2) Broken aggregate of sizes less or over 2½in. might be found preferable by some engineers.

(3) That such a surface with large-sized aggregate finished off with a tar carpet as advocated, gives a good foothold to horses, looks like asphalt and can be used on any gradient that is applicable to a tar-sprayed macadam road.

(4) It is my firm conviction that in such concrete roads, if scientifically constructed and reinforced with steel equally longitudinally and transversely, lies the secret of successful roads—cheap, good, free from corrugations, easily repairable and pleasing to all users thereof.

London, S.E. 18, October 16th. J. H. WALKER.

THE BRINELL BALL TEST.

SIR,—On reading the leading article in your issue of September 29th, it occurred to me that some useful information might be obtained by making hardness tests of the actual hardness impression produced by the 10 mm. ball used in the Brinell test, and I therefore had a series of tests made with the small ball hardness testing machine, using a 1 mm. ball at the centre of the 10 mm. ball impression. The table below gives the results of these experiments on various materials:—

	10 mm. ball hardness.	Hardness at centre of impression.
Mild steel	128	170
.40 per cent. carbon steel	302	341
.80 per cent. carbon steel	223	228
Chrome vanadium steel	183	192
Nickel-chrome air hardening steel annealed	228	228
Nickel-chrome air hardening steel annealed	212	212
Ditto, hardened, 800 deg. Cent.	512	512
Ditto, hardened and tempered, 600 deg. Cent.	269	269
High-speed steel annealed	255	285
Ditto, hardened	627 (± 10)	683
Gun-metal	80	115
Copper	75	80

Dealing with the steels, it would be noted that the mild steel is hardened considerably by the impression, and that as the carbon increases, the hardening effect of the impression diminishes, being very small with a steel having .80 per cent. of carbon.

The chrome vanadium-steel was hardened slightly.

The nickel-chrome air hardening steel showed no hardening effect at all, either in the annealed state or in the hardened or hardened and tempered states.

High-speed steel in the annealed and hardened states shows slight hardening.

Gun-metal shows a very considerable hardening, but copper only a slight increase of hardness.

After completing these tests, a further set of tests were made upon the mild steel and the nickel chrome steel specimens in the following manner. The hardness impressions were cut through the centre so as to give a transverse section of the impression, and the cut face so produced was polished and again tested with the small ball as near to the impression as possible. The results are given below:—

	Brinell No.	As near as possible to impression.
Mild steel	126	179/197
Nickel-chrome steel	241	285/293

It can be seen from these results that the mild steel showed greater increase of hardness tested in this way than by the first test; and the nickel-chrome steel showed a considerable increase of hardness, although no increase of hardness was shown by the first tests.

When the specimens were etched and examined under the microscope, it was found that the hardness lines produced by the 10 mm. ball extended past the area tested by the 1 mm. ball at the transverse test.

The net result of the experiments seems to be to show that the hardening effect of the ball is greater in an inverse proportion to the hardness of the material, but that in every case there is probably some increase in hardness caused by the pressure of the ball.

In view of the great interest which is now taken in hardness determinations, the results of these experiments might be of some value to future investigators.

Coventry, October 12th. P. V. VERNON.

RAILWAY BRIDGES.

SIR,—The subject of alloy steels referred to by Mr. White in last week's issue is fully dealt with by Dr. Waddell in his "Bridge Economics," but the absence of a definite offer of a high-tensile structural steel in the form of plates, angles and sections, whose strength and ductility, as well as price, are guaranteed, does not permit a really accurate calculation to be made concerning the practical economics of alloy steel for bridges. Such steel must be ductile, capable of being machined and riveted, not more corrodible than ordinary steel, and the next move is with the steel makers.

"Student I.C.E." suggests in your issue of September 29th that our present factor of safety is not too high. The experience of hundreds of engineers seems to show that our methods of design are certainly safe, seeing that failures are so extraordinarily rare as to be almost unknown. He may be sure that the "human element" he mentions is never really forgotten, and that the present movement for more "light" is not calculated to result in additional risk, but that clearer knowledge will produce more economy with the same factor of safety. His suggestion for testing bridges to destruction by means of derelict engines at high speed is not only impracticable, but unlikely to yield accurate data.

October 16th. CONRAD GRIBBLE.

CONTRACTS.—The Anderson-Grice Company, Limited, of Carnoustie, has been entrusted with the work of converting two hand overhead cranes into three-motor electric ones for the Edinburgh Corporation tramways. The cranes are normally rated at 15 tons and have a span of 50ft.—James Howden and Co., Limited, of Glasgow, have, during the last few months, secured orders for thirteen turbo-electric generating sets of various types, ranging in capacities from 3000 kilowatts to 750 kilowatts, and for two high-speed generating sets of 1000 kilowatts and 250 kilowatts capacity respectively, these orders being some for home and some for abroad. The same firm has also received an order for a 1000 brake horse-power turbo pumping set for the Canton waterworks.

QUEEN'S ENGINEERING WORKS ASSOCIATION.—The annual dinner of the past and present pupils of Queen's Engineering Works, Bedford, was held at the Trocadero Restaurant last Saturday, and was a delightfully friendly affair. Mr. Carmichael occupied the chair, with Mr. Howlett, the ever energetic secretary, opposite to him. After the Royal toasts had been drunk, the secretary read a telegram from the veteran chairman, Mr. W. H. Allen, and a reply that had been sent. Then Mr. Richard Allen proposed the health of the association, which was acknowledged by Mr. Carmichael. Mr. Harold Allen then called a toast to the guests, and Mr. Pendred responded. Engineer-Commander Hinchcliff proposed the chairman, and the chairman briefly responded. The dinner thereupon resolved itself into a smoking and chatting concert with great success.

PRESENTATION AT SHEFFIELD.—An interesting ceremony took place during the week at the office of the Brightside Foundry and Engineering Company, Limited, when the directors and staff joined together to do honour to one of their number who had completed forty years' service with the firm. The ceremony took the form of a presentation of an antique mahogany clock to Mr. Frank Biggin, who started work with the firm on September 27th, 1882. The clock was handed to Mr. Biggin by the managing director, Mr. T. H. Firth. Mr. Firth said that by sheer ability Mr. Biggin had risen from office boy to one of the highest possible positions, *i.e.*, a director of the company, in itself a notable achievement. In reply Mr. Biggin said that it was a great pleasure to accept such a splendid present, but he appreciated more the kindly thoughts which prompted such a gift. He was pleased if, after forty years' service, during which they had time and opportunities of seeing his deficiencies and faults, they still had a kindly feeling towards him. Any success which he had achieved in his business career he attributed to the splendid loyalty of the staff which had worked with him.

THE CHELMSFORD ENGINEERING SOCIETY.—On Thursday, October 12th, in the Rooms of the East Anglian Institute of Agriculture, the president, Captain H. Riall Sankey, presiding, Mr. Borlase Matthews gave an illustrated lecture on "Electricity Applied to Agriculture." Various types of electrical ploughing machinery were explained, also methods of making hay from stacks of wet grass by electrically blowing air through them. The electroculture of crops by the "Corona" effect from overhead wires was explained, and it was claimed that this method resulted in a 10 per cent. increase in the crops. It was shown that chaff cutting, sheep shearing, milking, butter making, and, in fact, any operation requiring a rotary motion, could very conveniently be carried out by means of electricity. Poultry runs may be illuminated by electricity during the evenings and early mornings, giving the birds a longer feeding time and resulting in a 20 per cent. increase in the number of eggs in winter. An incubator with a capacity for 10,000 eggs in which an electric radiator supplied the heat, an electric fan provided the air circulation and the eggs were automatically turned, caused considerable interest. During the discussion which followed it was suggested that electricity supply companies and makers of electrical machinery would do well to turn their attention to this new opening, and while extending their activities to the rural districts, help to increase the food production of the country.

A Seven-Day Journal.

The Gliding Competition.

The gliding competition for a prize of £1000 offered by a contemporary began on Monday on the Downs near Lewes, Sussex. On the first day the best performance was that of Fokker, who succeeded in remaining in the air for 37 min. 6 sec. Several other competitors flew for from 2 min. to about 11 min. On Tuesday, Raynham far surpassed all previous performances by remaining up for 1 hour 53 min. On Wednesday the wind was too strong to permit any serious attempt being made to continue the flights. A visit to the Downs on Tuesday did not leave us with any great enthusiasm for gliding. The competitors were at liberty to take off at any point over a four-mile length of ridge from 400ft. to 700ft. high, and as neither the organisers nor the pilots themselves seemed to have any sort of programme the spectators, of whom there were several thousands, were led hither and thither by rumours or signs of possible flights, only to find themselves too late or disappointed. Those who were lucky enough to see Raynham's flight in the morning assured us that it was a fine performance. No doubt it was, but from the technical or scientific point of view it demonstrates that gliding is scarcely likely to become anything more than a new form of sport. It may perhaps be worth noting that the object of starting a glide from the top of a hill is not to take direct advantage of the fall of the land, but to utilise the upward currents of wind which usually prevail over the face of a hill. The machines do not glide in the aeroplane sense, but fly on the wind and repeatedly pass over their starting point at heights equal to or even greater than that to which they originally ascended on being released.

Motor Vehicle Taxation.

At the invitation of the Ministry of Transport a number of organisations representing various branches of the motor industry have submitted proposals for a new form of taxation. These bodies include the Royal Automobile Club, the Royal Scottish Automobile Club, the Society of Motor Manufacturers and Traders, and the Motor Trade Association. The proposed system is chiefly a tax on motor spirit, its main features being as follows:—A flat rate duty on all motor spirit to be levied at the port of entry; all motor spirit derived from imported crude oil to be taxed; a moderate registration tax on all motor vehicles; no rebates of motor spirit tax for any class of road motor; no tax on benzol or any other motor fuel that is wholly produced in this country; duty-free petrol for aviation and industrial purposes, which is to be supplied by a simple permit system; motor spirit to be defined by flash point and distillation tests; the use of paraffin in internal combustion engines to be allowed by special licence; steam and electric vehicles to be taxed by the existing method. It is stated that a definition of motor spirit has been drawn up which will solve the difficulties encountered in the administration of the petrol tax which was formerly in operation.

A Greenock Unemployment Scheme.

A scheme for the relief of unemployment in Greenock which embodies a somewhat novel but none the less important proposal was submitted to the Greenock Corporation last week. Under this scheme the Corporation would assume responsibility for building three 10,000-ton cargo steamers, the work being done in the local yards, and only Greenock men employed. The proposal was favourably considered by the members of the Council, and it was decided to appoint a committee to meet representatives of both the employers and the men, and also to approach the Secretary for Scotland for the necessary sanction. Bailie Brown, the propounder of the scheme, has carefully considered the matter from all points of view, and according to his estimate, even if the steamers were completed and sold at a loss, the deficiency would be less than the money paid to the unemployed men during the time the ships are being built, which time is reckoned at about six months. It is felt that a strong case could be made out for Government aid in financing the scheme, since most of the unemployed in the district are shipyard workers.

The Over-production of Rubber.

The supplementary report of the Colonial Office's Committee appointed to consider the position of the rubber-growing industry in the British Colonies and Protectorates contains certain revisions of the recommendations expressed in the June report. The Committee now recommends that a scheme of Government intervention should be put into force as soon as possible in Ceylon, the Malay States, and the Straits Settlements. The actual output of each producer between November 1st, 1919, and October 31st, 1920, is to be taken as his standard production. The minimum rate of duty would be 4d. per pound, and would in the first instance be levied on output exported up to 60 per cent. of the standard production. Thereafter the duty would increase until it amounted to 1s. per pound on the whole of the quantity exported if that quantity exceeded 100 per cent. of the standard production. The standard price of smoked sheet rubber landed in London is taken at 1s. 3d. per pound. If this price is maintained or exceeded over a period of three months, the quantity which would be permitted for export at the minimum duty during the next quarter would be 65 per cent. of the standard production, and 70 per cent. if the price were maintained at not less than 1s. 6d. per pound. On the other hand, if the price maintained were less than 1s., the quantity exportable at the minimum duty would be reduced to 55 per cent. of the standard production, with a further reduction to 50 per cent. if the first were not effective during the three months following its application in raising the price to 1s. 3d. per lb., with additional 5 per cent. reductions every three months until that price were secured. This attempt to restrict production and secure a standard price by Government control will be watched with great interest by students of political economy.

The Port of London Building.

There may be many differences of opinion about the beauty and fitness of the great building on Tower-hill which will accommodate the Port of London Authority, and which was opened on Tuesday by the Prime Minister. Many people will deplore the fact that the immense tower over the entrance in Trinity-gardens dwarfs into insignificance the charming little Trinity House, and even challenges the Tower itself; but after all is said and done, this monumental feature, with its colossal statuary, does typify the might and power of the richest port in the world in the greatest city in the world, and that is something gained. It has always been the business of great architecture to embody the sentiments that inspired its buildings, and if there is a certain amount of what has been called magnificent swagger in Mr. Edwin Cooper's splendid edifice it is surely justified—rather, indeed, proper pride than mere ostentation. As the tower is the most notable object of the exterior, so the great rotunda which occupies a central position in the plan is the element which attracts attention in the interior. It is a magnificent circular room 110ft. in diameter, with a vast domed ceiling broken up into numerous panels and supported by a large number of paired columns. A word of praise must be given, too, to the admirably designed corridors which connect the offices. Altogether, London, by the completion of this great edifice, finds itself in possession of a new building of which it may well be proud, and on the design and construction of which it may heartily congratulate the architect, Mr. Edwin Cooper, and the chief contractor, John Mowlem and Co., Limited.

The Cumberland Mine Disaster.

The coroner's inquest on the victims of the disaster which occurred on September 5th at the Haig Pit of the Whitehaven Colliery Company was concluded on Saturday. It produced some disquieting evidence from Professor R. B. Wheeler, of Sheffield University, and Director of the Government Testing Station at Eskmeals, as to the explosibility of moist coal dust. He stated that recent experiments had shown him that coal dust containing as much as 30 per cent. of water, virtually a thin mud, could propagate an explosion. Although presumably such dust cannot initiate an explosion, the fact that it can carry one on once started is a matter for grave consideration, for hitherto protection from coal dust explosions has been largely sought by watering the dust. It would now appear that such watering is of little or no value in stopping the spread of an explosion, and that the exceptions made in the Mines Act in favour of coal mines which are naturally wet throughout are misleading. The Haig Pit disaster, according to Professor Wheeler, was probably initiated by a gaseous explosion arising from shot firing, and was propagated by the moist coal dust. The jury adopted this view, and expressed the opinion that in the future shot firing in this particular mine should not be permitted.

Our Coal Reserves.

In a presidential speech in Birmingham on Monday last Professor W. S. Boulton said that quite recently a set of cores had been brought to the surface whilst boring for water in the city of Birmingham, and from an examination of them he was forced to the conclusion that there were no thick coal seams in that locality. In other parts of the coalfield prospects were more favourable, and Professor Boulton mentioned especially the borings and sinkings at Whitmore Park and Keresley, which had added nearly 40 square miles to the concealed coalfield as delineated by the Royal Coal Commission of 1905. Yet despite all recent developments he feared that the country would be feeling the pinch in a few generations, and he held out no hopes that oil would for long fill the gap. The natural "oil age," he believed, would be very transient, and for years to come coal must remain the world's great stand-by as a fuel. Speaking of the systematic borings for oil in Derbyshire, he expressed the opinion that since that exploration had been carried out in areas and on sites which were well chosen for the purpose, the disappointing results pointed to the probability that the chances of tapping natural oil in commercial quantities in this country were exceedingly slender.

Gas by the Therm.

The dissatisfaction which, rightly or wrongly, many of the public feel with the system of charging for gas consumption by the therm has found a reflection in the proceedings of the London County Council. That body on Tuesday considered and adopted a report presented by the Public Control Committee on Gas Supply in which, after advancing evidence of the discontent expressed by gas consumers, it recommended that the County Council, as the local authority under the Gas Regulation Act of 1920, should apply to the Board of Trade to make an immediate inquiry into the matter and to issue orders revising the present authorised standard prices of gas in the London area. Any action in this respect by the Council would, of course, give a lead to other authorities throughout the country. Meanwhile, a very warm defence of the therm was advanced by Sir George Davies at Bristol on Tuesday in his presidential address to the British Commercial Gas Association, which we report on another page.

Sir Eric Geddes.

On Wednesday the Grand Council of the Federation of British Industries unanimously decided to nominate Sir Eric Geddes for the position of President for the coming year, in succession to Colonel O. C. Armstrong. The actual election will be considered at the annual meeting of members of the Federation to be held next month.

Railways of Europe.

A recommendation was made by a Committee of the Genoa Conference that the technical representatives of all the railway administrations of Europe should be called together to discuss the possibility of establishing an International Railway Union. A meeting was accordingly arranged, and sittings began in Paris on Tuesday last under the presidency of M. Le Trocquer, Minister of Public Works. In an opening address M. Le Trocquer dwelt on the confusion and congestion that existed on all European railways soon after the war ended, and said the object before the conference was to construct an International Railway Union which would ensure co-ordination and unity amongst the railways of Europe, and would be also a co-ordinating factor in the world's railways.

Oil Storage Tanks.

We hear that an important order has been placed with British makers for oil-storage tanks. These tanks are to be erected at the various coaling depôts owned by Cory Brothers, of Cardiff, on the chief shipping routes. Of these depôts there are about one hundred, and the value of the order is stated to be £70,000. It is a striking fact that Cory Brothers, who are known throughout the world for coal supply, should have seen the necessity for meeting the ever-increasing development of oil fuel supply. The present orders will, in all probability, be followed by others from the same firm. In this connection it is interesting to note that at the Agwi Petroleum Corporation's refinery at Fawley, on Southampton Water, a large storage tank, capable of holding 8000 tons or 55,000 barrels of oil, has just been completed ready for use within twenty-one working days since the beginning of erection work. For a tank of this size—it measures 114½ft. in diameter and 30ft. high—this performance is claimed to constitute a record. The tank was erected by Sir John Payne Gallwey, Limited, the firm responsible for the whole of the Corporation's plant at Fawley. That plant now has a storage capacity of 50,000 tons of oil, and can refine 1000 tons of crude oil per week. The whole of the plant, including the power-house, the pipe lines, and the deep-water wharf, was erected and in operation within twelve months of the purchase of the site.

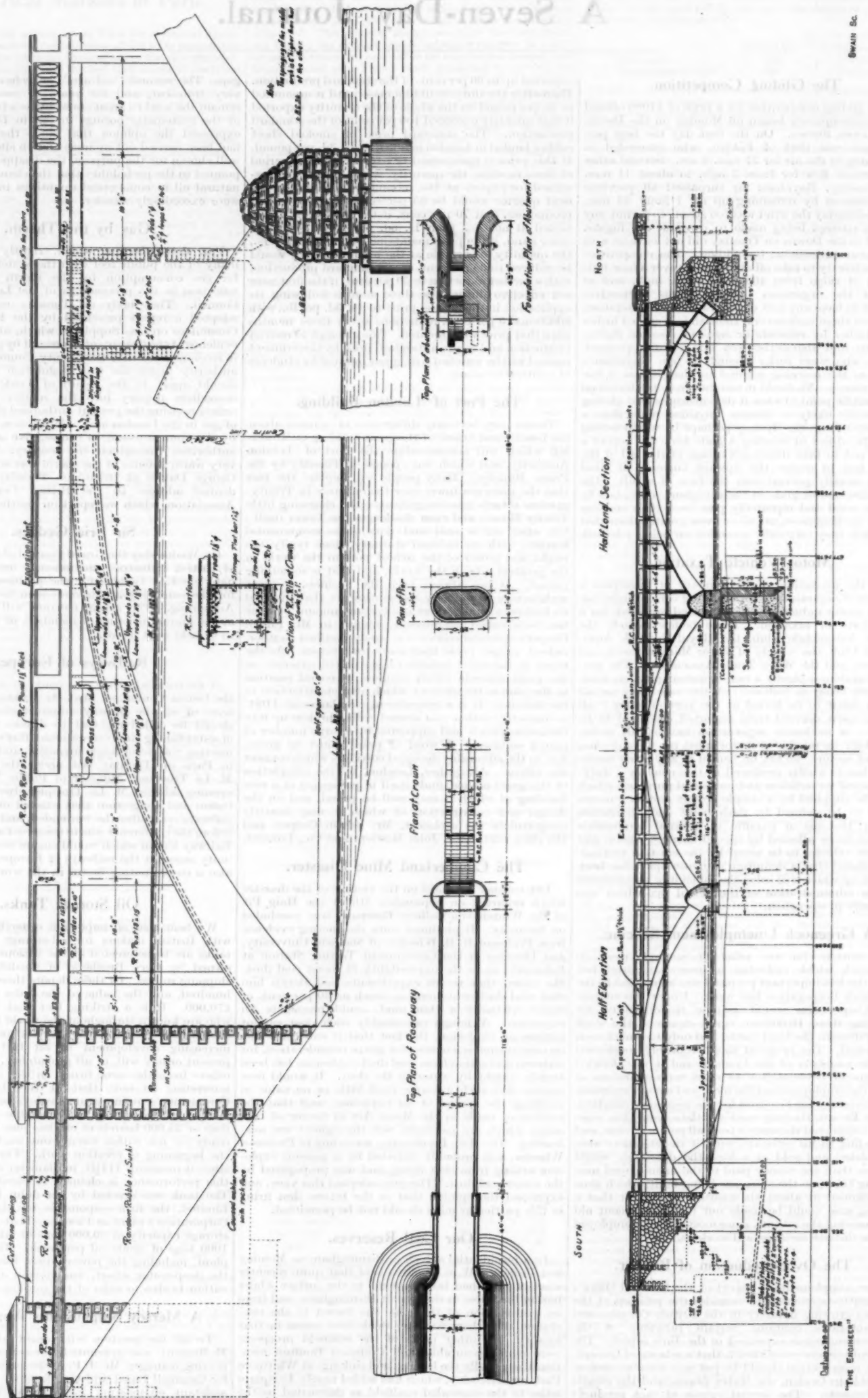
A Mersey Shipbuilding Appointment.

To fill the position left vacant when Mr. W. H. McMenemy was appointed, some months ago, engineering manager, Mr. J. P. Anderson has been selected by Cammell Laird and Co., Limited, for the post of assistant engineering manager at the Birkenhead shipyard. Mr. Anderson was for a time assistant chief engine draughtsman with Messrs. Scott's, of Greenock, and for the past two years or so was chief draughtsman with Messrs. Workman, Clark.

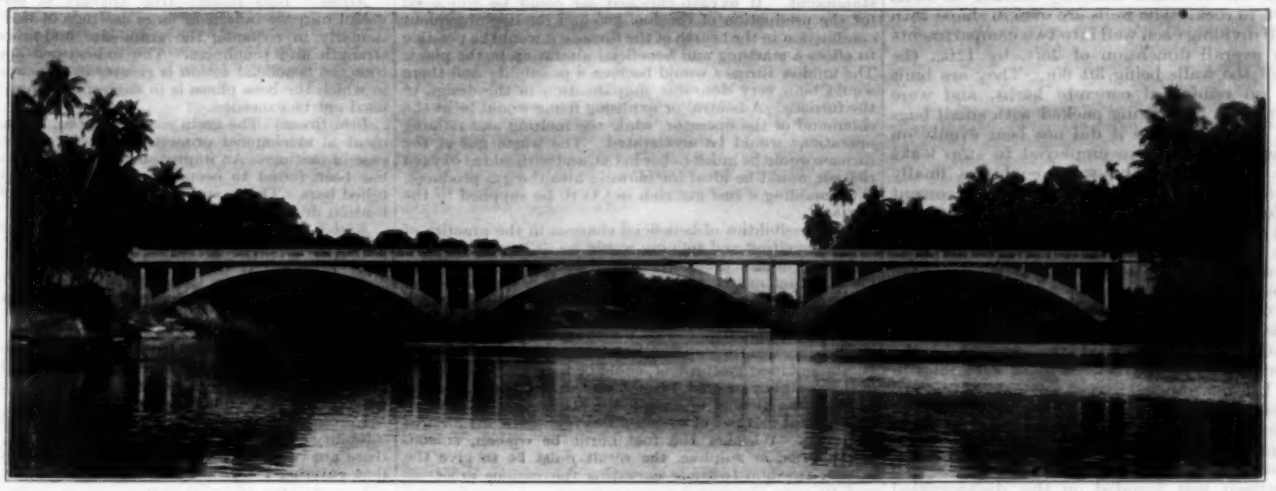
REINFORCED CONCRETE BRIDGE OVER THE RIVER PAMBAYAUR, S. INDIA

MR. A. H. BASTOW, M. INST. C.E., AND MR. F. J. JACOB, ENGINEERS

(For description see opposite page)



REINFORCED CONCRETE BRIDGE OVER THE RIVER PAMBAYAUR



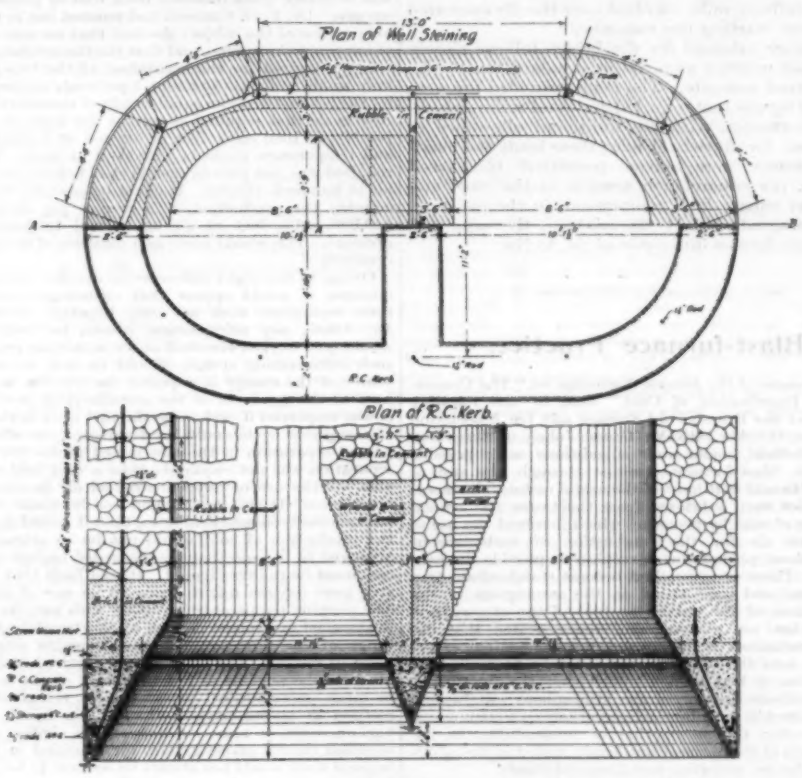
Reinforced Concrete Bridge Over the River Pambayaur at Chengannur.

A REINFORCED concrete bridge at Chengannur, in the State of Travancore, South India, has recently been completed. It crosses the Pambayaur River at the seventy-sixth mile of the main road from Trivandrum, the capital of the State, to the Northern frontier adjoining the native State of Cochin. The bridge was designed by Mr. A. H. Bastow, M. Inst. C.E., Chief Engineer of the Public Works Department, who retired soon after the commencement of the work, and was completed by his successor, Mr. F. J. Jacob, Chief Engineer, Mr. O. S. Barrow and Mr. R. Everard, M. Inst. C.E., being respectively acting chief and deputy chief engineers during the period of construction. The executive engineer in charge was Mr. L. H. Jacob, and the contractor, Mr. G. Marini.

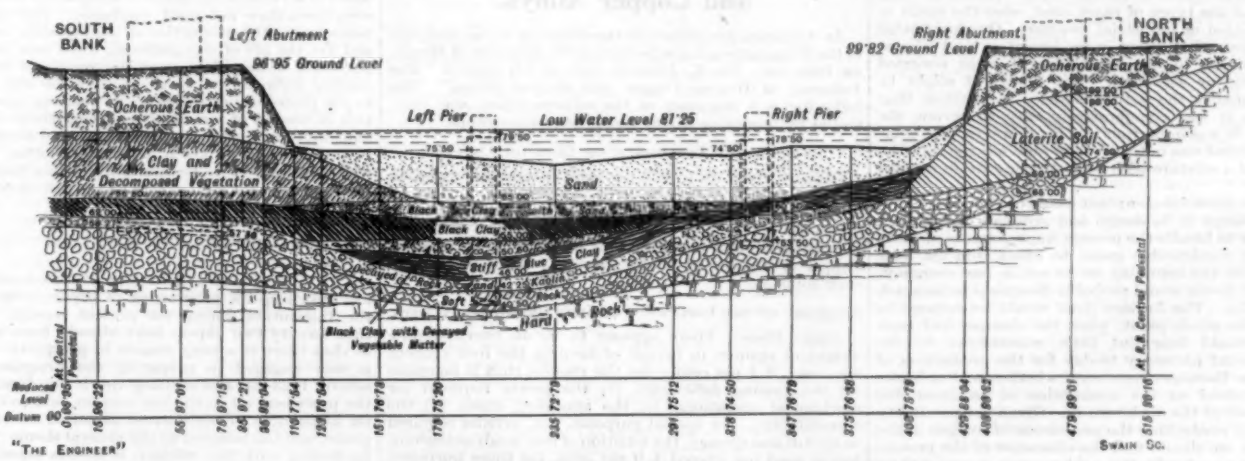
The Pambayaur River has a catchment area of 750 square miles, the average annual rainfall in the basin being approximately 170in. In the dry season from January to April the velocity in the river is small, and the maximum depth of water does not exceed 10ft. or 12ft. The advance of the south-west monsoon commences in the month of April and attains its maximum about the end of June. The river then rises bank high with heavy velocity, the height of the maximum flood experienced during construction being 6½ft. below the centre of the intrados of the arch rib. On three occasions during construction the open foundations for the abutments were submerged and much damage was done by washing away of flood protection banks and silting of the excavation. Work on the piers and wells had also to be suspended more than once.

The bridge, which is illustrated in the accompanying engravings and by the drawing on page 410, is of the open spandrel type, and consists of three clear spans each of 120ft. Each span has two ribs 2ft. wide, rectangular in cross section and spaced at 10ft. centres. The depth of the rib varies from 3ft. at the crown to 7ft. at the springing. The ribs have been computed for a uniform reinforcement throughout of 1 per cent. of the sectional area of the rib at the crown, ½ per cent. being placed 3in. from the extrados and ½ per cent. at an equal distance from the intrados. To provide for the tension at the intrados at the crown, and at the extrados at the haunches, extradosal reinforcement was increased to 1 per cent. of the crown section and was carried right through. The intradosal reinforcement was made 1 per cent. of the crown section for the middle five bays and none at all for the rest of the intrados. The steel bars are held together by flat bar shear loops of 1in. by ¼in. cross section.

The deck, having a 15ft. clear roadway, is carried by two longitudinal beams on spandrel posts designed to act with the floor slab as T beams. At the crown these beams merge into the rib. The spandrel supports are 19in. by 19in. pillars connected at the top by cross girders. The deck slab is 8in. thick, and is



PLAN AND SECTION OF BOTTOM OF WELL FOR PIER



GEOLOGICAL SECTION OF THE RIVER AT THE SITE OF THE BRIDGE

it was found advisable to double the reinforcement at the extrados for three bays near the haunches and at the intrados for five bays at the centre. Thus the eleven rods of 1½in. diam. were used for the extrados throughout, and eleven rods of the same diameter for the five bays of the intrados. These round mild

furnished with kerb beams to retain the floor which consists of teak blocks 5in. by 4in. by 3in., with a cushion of sand 3in. deep above the concrete floor slab.

The piers are of ashlar masonry carried on wells taken down to rock. The wells are oval in shape with a cross wall dividing each well into two compartments having an overall dimension of 25ft. by 12ft., the thickness of the walls being 3ft 6in. They are built of rubble on reinforced concrete kerbs, and were pumped dry, the kerb being packed with small bags of cement concrete where it did not bear evenly on rock surface. Divers were employed to stop leaks under the kerb before the wells could be finally de-watered. The wells were then filled with cement concrete for a depth of 8ft., over which sand was filled, and the top was completed with cement concrete over which was built the ashlar masonry pier. The false-work and boxing were carried on wooden piles braced with old iron rails, with wrought iron girders in the centre of each span, a clear opening of 20ft. to pass floods and boat traffic being left.

The geological formation of the ground in the district consists of gneiss rock overlaid with laterite and sand. It is not unusual to find a deposit of broken-down gneiss overlaying the solid rock to a depth of several feet. This deposit varies from quartz sand highly impregnated with kaolin to very soft disintegrated rock grading off into the solid gneiss. The south abutment was founded on this disintegrated rock, which was there found to be sufficiently hard to require removal by pickaxe. To prevent sliding of the abutment by reason of the action of the thrust of the arch ribs and also as the result of unequal settlement, a slab of concrete 12in. thick, reinforced with old railway rails, was laid over the disintegrated rock before starting the masonry.

The design adopted for the bridge follows closely the current practice as given in standard text books on reinforced concrete. The loads provided for were 80 lb. per square foot, or a 14½-ton road roller, whichever was greater, with an additional allowance of 25 per cent. for impact. Under these loads the maximum stresses were never permitted to exceed 16,000 lb. per square inch tension in the steel and 600 lb. per square inch compression in the concrete, which consisted of 1 : 1 : 2½ mixture, the aggregate being gneiss broken into cubes of ½in. to ¾in.

Blast-furnace Practice.

In the course of the general discussion on "The Generation and Distribution of Cold," held by the Faraday Society and the British Cold Storage and Ice Association on Monday, October 16th, Mr. Cosmo Johns, of River Don Works, Sheffield, made some suggestions as to possible changes in blast-furnace practice through the use of oxygen. He said that most of the useful metals in present-day practice were extracted from their ores and refined for the use of man by processes which involved the use of atmospheric air for the combustion of carbonaceous matter, silicon, phosphorus or sulphur to provide the heat required. These processes had become standardised to a large extent and were based on the assumption of the invariableness of the oxygen content of the atmosphere. Until Gayley, not so long ago, demonstrated that the seasonal variations in the aqueous vapour content of the air blown into the blast-furnace could be controlled by refrigeration, it had been assumed that the fluctuating aqueous volume content of the atmosphere was beyond human control in metallurgical operations on a commercial scale. To-day the assumption of invariability in the oxygen ratio of the air used was firmly rooted in the minds of those who are operating metallurgical plants.

Obviously, continued the speaker, the oxygen enrichment of the air used would alter the conditions under which these metallurgical processes which depended on oxidation of some fuel for the heat required were carried out; and though it was difficult to predict what would actually be the effect of such altered conditions, yet enough was known to enable us to say that revolutionary changes in metallurgical practice would result. The processes now employed, and the types of plant used, were the result of gradual evolution of industrial practice. Our knowledge of the reactions that occur were imperfect and almost entirely restricted to our knowledge of what occurred when ordinary air was used. But though it might be difficult to predict the actual changes in practice that would result, it was comparatively easy to review the possibilities. It was important to note, however, that what was contemplated was not the use of pure oxygen, but the availability of a mixture with 30 to 40 per cent. of oxygen or even less.

The modern blast-furnace plant would obviously undergo a startling change in its design and arrangement when it had no longer to handle the present huge volumes of dust-laden heated combustible gases to effect difficult heat exchanges with the incoming air to secure fuel economy. The hot blast stoves would probably disappear or be much reduced in size. The furnace itself would be reduced in height and the whole plant, when the changes had been completed, would bear but little resemblance to the equipment found necessary to-day for the production of pig iron. The Bessemer converter, whether acid or basic, had been evolved on the assumption of an invariable oxygen content of the air blown in. Given the possibility of varying and controlling the proportion of oxygen in the air employed, we should find the character of the process completely changed. In the acid process it was known that the order in which carbon and silicon were removed depended on the temperature. In the basic process it was almost certain that by controlling the temperature it would be possible to oxidise the phosphorus before all the carbon had been removed, and thus the injurious after blow would be avoided. This temperature control could be effected if the oxygen content of the air blown in could be varied.

The regenerative open-hearth steel melting furnace was costly, complicated and inefficient from the thermal standpoint. If oxygen-enriched air could be employed for the production of the fuel gas and for its subsequent combustion in the hearth of the furnace it would be possible to effect a startling and beneficial alteration in the plant. The uniflow furnace would become a possibility and there would be a very desirable simplification in the design of the furnace. A neutral or oxidising flame would be at the command of the operator, while the melting and refining operations would be accelerated. The waste gas of the furnace would be much richer in CO_2 and with added oxygen rich air would be ideal for blowing into the gas producer, thus enabling a fuel gas rich in CO to be supplied to the furnace.

The possibilities of beneficial changes in the practice of copper smelting and refining would be as great as in iron and steel works practice. Pyretic smelting would lose many, if not nearly all, its difficulties if it were commercially possible to vary the oxygen content of the air used, while the bessemerising of copper matte would be accelerated. Most important of all would be the possibility that the waste gases, now difficult to handle owing to the vast volumes of inert gas present, could be used for the recovery of their sulphur content. But it was unnecessary to pursue further this review of metallurgical possibilities once a commercial method of giving an oxygen-enriched air was available. Whether the fuel burnt be carbon, silicon, phosphorus, or sulphur, the result must be to give the greater freedom to those operating the various processes and to open the way for new advances in metallurgical practice.

It was, continued Mr. Cosmo Johns, important to note that it was not pure oxygen that was required. It would be amply sufficient if the oxygen content could be varied between the range of 20 and 40 per cent. The problem was therefore quite different from that of preparing pure oxygen. Dr. F. G. Cotterell had pointed out in his admirable review of the subject the fact that air was a mixture of oxygen and nitrogen, and that the theoretical amount of energy required for the separation of the two gases was very small, in fact only about 1 per cent. of that required for the production of an equal weight of electrolytic oxygen. Any cycle that required energy of the order of 30 horse-power per 1000 cubic feet of oxygen at normal pressure and temperature could be ruled out at once. What was required was, not pure oxygen in steel bottles, but enriched air in hundreds of tons. It could be assumed that in this country the production of a ton of pig iron required 140,000 cubic feet of air at normal temperature and pressure. This would serve as a measure of the quantities involved.

Owing to the slight difference in density of oxygen and nitrogen it would appear that centrifugal methods for their separation were not very hopeful. Could, asked Mr. Johns, any refrigerating system be devised which would give oxygen enriched at a commercial price? Any such refrigerating system should be able to use as the source of the energy it required the sensible or potential heat of the products of the metallurgical process where it was employed if carbon be the fuel used in the process. If a suitable cycle could be discovered for effecting the partial separation of the two mixed gases—for complete separation was not required—then a vast field was available for the use of oxygen-enriched air in metallurgical operations. If this cycle could not be made to operate on sufficiently economical lines, then it would appear that the production of cold would not be so attractive as it appeared to be, and that the discarded barium oxide process must be re-investigated. Its old fault that it did not give pure oxygen might prove to be one of its virtues. The working temperature at which with varying pressures it absorbed or evolved oxygen was fortunately within the range of the now available impermeable alloys which resist oxidation. The temperature required could be supplied by the sensible or potential heat of the waste gases in many metallurgical processes. If refrigeration as a method of giving oxygen-enriched air failed, then the barium oxide or some substance with similar properties required careful investigation, for mankind in its metallurgical work would not always be content to be controlled by the atmosphere Nature provides.

The Influence of Iron on Copper and Copper Alloys.

In delivering his address as the chairman to the members of the Birmingham Local Section of the Institute of Metals, on 10th inst., Dr. F. Johnson took as his subject "The Influence of Iron on Copper and Copper Alloys." The following is a summary of the address which was illustrated by numerous tables and photo-micrographs.

Summary of Influence of Iron on Copper.

Copper.—Iron up to 0.5 per cent. deoxidises, toughens and strengthens copper, even in the presence of arsenic. It has a powerfully inimical influence on electrical conductivity and a very small quantity makes the metal paramagnetic and unsuitable for using in galvanometers. Copper is capable of holding about 3 per cent. iron in solid solution.

Summary of the Influence of Iron on Copper Alloys.

Alpha Brass.—There appears to be an overwhelming weight of opinion in favour of keeping the iron content low—say, 0.1 per cent.—for the reasons that it increases (*a*) the casting difficulties, (*b*) the power required for mechanical operations, (*c*) the annealing costs, (*d*) the corrodibility. For special purposes, *e.g.*, articles required to be stiff and springy, the addition of iron is advantageous, but it need not exceed 1.0 per cent. for these purposes. Advantage might be taken of the influence of iron in raising the annealing temperature of cold-worked alpha brass, to increase the convenience of the low-temperature annealing processes for the removal of internal stresses of cold-worked material. A slightly higher temperature of annealing would mean a shortening of the annealing period—an advantage in works practice. To what extent this would affect the oxidising annealing treatment proposed by Dr. Bengough, or the corrodibility of such treated tubes, has not been investigated.

Alpha + Beta Brass.—Iron appears to serve a very useful purpose indeed in large castings of this type, particularly in reducing the grain size and improving the strength and toughness. The indications appear to be that the beneficial action is greater in the case of brasses in which the beta phase is in excess, and that 1 per cent. need not be exceeded.

Beta Brass.—The grain size is reduced, but no improvement in mechanical properties appears to accrue in the case of castings. An improvement, especially in ductility, has been found to occur in the case of hot-forged and rolled bars. This may be due to retardation of recrystallisation during the hot-working process.

Nickel Brass (*Nickel Silver*).—The addition of iron has been specially recommended for cutlery stock and extra hard springs.

Copper-Aluminium (*Aluminium Bronze*).—Iron up to 4 per cent. has been found to be very beneficial in reducing grain size, retarding crystal growth and facilitating the production of die castings.

Admiralty Gun-metal.—Iron up to 1 per cent. does not appear to be detrimental if correctly alloyed. The mechanical properties are enhanced under such conditions, in the case of small chill castings.

In most of the alloys examined, the limit of solid solubility occurs at less than 1 per cent. iron. In brass there are two forms in which the iron exists in excess of that entering into solid solution, viz.:—(1) As free iron-rich crystallites, globular or cruciform in shape. These are pale blue, but turn black when etched. (2) As very minute uniformly distributed dark-etching particles. As a rule, the beneficial influence of iron ceases at the degree of concentration at which the free crystallites (1) appear.

AN INSTITUTE OF PAINT AND VARNISH TECHNOLOGISTS.

It was decided, at a dinner attended by members of the Oil and Colour Chemists' Association and the Paint and Varnish Society, on October 11th, to take steps to form the Institution of Paint and Varnish Technologists. Attempts to secure greater co-operation in the paint and varnish and oil and colour industries have been made for some years, and the discussions which have taken place in this connection have now culminated in the decision to form the new body. The industry has been represented hitherto on the technical side by two bodies, namely, the Paint and Varnish Society and the Oil and Colour Chemists' Association, which have been working independently. Last year discussions took place between the Paint and Varnish Society and the Society of Chemical Industry, the object being to endeavour to form a paint and varnish group of the latter body. The Oil and Colour Chemists' Association then got into communication with the Paint and Varnish Society, and subsequently the idea of forming a group of the Society of Chemical Industry was abandoned in favour of the formation of a comprehensive institute of paint and varnish technologists, which should include within its membership, not only the scientific and technical workers in the industry, but the manufacturers themselves. The scheme has now received the unanimous approval of both bodies, and a provisional committee, consisting practically of the Councils of the two bodies, has been formed to draw up a definite scheme to be submitted to the members on both sides. The adoption of this scheme, of course, will involve the disappearance of the two existing bodies.

The industry represents many hundreds of firms, employing, in the aggregate, about one million workers, and having a capital of several millions sterling. Many manufacturers have supported the scheme so far as it has gone, and it is upon them that the chief responsibility in the matter of finances will rest. Proposals have been made in this direction, one being that each firm should, at any rate for the first year, subscribe £10, and another that an annual subscription based on the capital of the particular manufacturers should be levied. Whatever scheme is adopted, however, there will have to be strong financial support.

One of the activities of the new body will be the prosecution of organised research, quite apart from that which is conducted in private laboratories. The corrosion of iron and steel used for structural purposes costs this country many millions of pounds per annum, and the vast importance of investigating means of adequately protecting these structures does not need emphasis. Very great care is necessary in the production of high-quality iron and steel, and yet the life of this material, when used for structural purposes, is dependent upon the quality of the protective coating given to it. In this connection also, in addition to the protective qualities of the coatings used, investigation is needed of means of rendering those coatings permanent, or at least more permanent than some of them are at present. There are a great many other problems to which attention is to be directed, but this instance emphasises the need for an institute which will be representative of all branches of the industry.

The Council of the Institution of Automobile Engineers has drawn up the programme of papers to be read before the Institution during the present session, and no less than twenty-two papers have already been arranged for, so that there is a busy session in prospect. The Council is now engaged in preparing the programme for the session 1923–24, and in doing this it has decided to follow the precedent set in the last session, and to endeavour as far as possible to concentrate attention on one particular phase, and has selected as the general theme "Economy." In dealing with this subject, it desires especially to concentrate on the question of accessibility as it affects reduction of first cost and maintenance costs and as a selling point. The Crompton Medal for the session 1922–23 has been awarded to Mr. H. F. L. Orcutt for his paper on "Motor Car Gear-boxes."

Railway Matters.

The Pennsylvania system, during the year ended May 31st last, carried 152,000,000 passengers without a single train accident in which a passenger was killed.

The railway accidents and railway inspection branches of the Ministry of Transport are now part of the secretarial department. The department of public safety and general purposes has ceased to exist.

From the life of Dr. William Robinson, the inventor of the closed track circuit, who died in Brooklyn on January 2nd, 1921, it appears that he was born in Ireland and, we judge, went to America in his youth, as he graduated there in 1865.

The announcement is made that Mr. C. Crump, the Great Western Company's divisional locomotive superintendent at Old Oak Common, has been appointed the company's running superintendent and outdoor assistant to the chief mechanical engineer.

It is officially announced that from January 1st all third-class fares, whether single or return, will be at 1½d. per mile and all first-class fares at 2½d. per mile. Cheap day tickets and week-end tickets, being based on the single fare, will be correspondingly reduced.

The Underground Railway people are about to introduce some new carriages, the internal decoration of which is intended to "ensure a more cheerful environment for the traveller." The upright poles provided for standing passengers to hold are to be replaced by the lately discarded hanging straps.

When it is stated that there are nearly eleven million licensed motor cars in the United States it will be appreciated how big is the task of educating drivers to cross the railways at road level crossings with caution. The railway companies are, however, persevering. They have issued 1,300,000 posters and have occupied space in the Press to the extent of two miles of matter.

It is reported that during the next five years Rs. 4 crores will be spent on the Burma railways. The addition of twenty superheated engines and forty-two modern engines before the end of this year is contemplated. The improvements also include the addition of a considerable number of coaches and wagons, the building of a number of new stations, and the re-modelling of station yards.

It is now nearly two months since the death of Sir Francis Gore-Browne, K.C., the chairman of the Railway Rates Tribunal, but no successor has yet been announced. Under Section 20 of the Railways Act the office is to be filled by "an experienced lawyer," and the appointment is to be made on the joint recommendation of the Lord Chancellor, the President of the Board of Trade, and the Minister of Transport.

A *Chicago Tribune* telegram states that it is estimated that the railway shopmen's strike has cost the United States, directly and indirectly, five hundred million dollars. Loss of wages alone amounted to one hundred millions, the companies lost fifty millions in freight traffic, while the value of perishable foods wasted during transit was seventy-five millions. Added to all this waste, there was the business lost by commercial houses through inability to send their goods or to receive material.

Speaking on the 13th instant at a dinner at which the companies of the Eastern, North-Eastern and East Scottish group were well represented, Colonel Galloway, a Great Eastern director, said that on his right and on his left he had men who knew railwaymen, their feelings, aspirations, and desires, and he felt sure than those men, who would largely have to advise upon the changes that would be made, would offer no solution that did not protect down to the last rung of the ladder every individual member of the staff. He asked them, in the changes that were about to take place, not to adopt beforehand a mood of rebellion.

It was in July, 1919, that we announced that Mr. Charles Aldington had been appointed general manager to the Great Western Railway, and only as recently as June 24th, 1921, had we to mention the appointment of Mr. Felix J. C. Pole to that office on Mr. Aldington's retirement owing to ill-health. Now, with regret, we have to announce the death of the latter on the 15th instant. Like his predecessor and his successor, Mr. Aldington rose from a junior clerk at a country station to the highest office under the company, and, like Mr. Potter, Sir Guy Calthrop, Mr. Bowen Cooke, and Sir James Ball, his death was mainly due to war strain.

The motor train, a new feature on Australian railway lines, is at present enjoying a considerable amount of prominence. It is regarded as providing a solution of the problem of the hitherto embarrassing non-paying branch lines in the country districts. Experimental services have been in operation in both Victoria and New South Wales, and are said to have given complete satisfaction. The Railway Commissioners hope shortly to have in service in New South Wales a fleet of twenty rail motors of a type far superior to the experimental car on the North Coast, which is simply a converted motor car with a 40 horse-power engine. The new type is to be fitted with a six-cylinder reversible engine of approximately 150 horse-power, supported on springs under the centre of the car.

According to a report of the general management of the Swiss Federal Railways, 357 kiloms. have been electrified up to the present (among them the well-known St. Gotthard line). In the course of 1923 and 1924, electrification work will be concluded on 239 kiloms. By the autumn of 1924 it is expected that about one-third of the Federal network will be electrified. The electrification of these lines will cost close upon 350,000,000f., to which 128,000,000f. must be added for rolling stock. The total amount thus reaches 478,000,000f., of which 300,000,000f. will be paid by the end of this year. Of the 178,000,000f. to be paid between 1923 and 1926 for electrification purposes, 50,000,000f. are for electric locomotives. The coal saved on the lines electrified up to the end of 1926 will, it is estimated, amount to 318,000 tons yearly, *i.e.*, 45.4 per cent. of the Federal Railways' total consumption of coal in 1913.

Notes and Memoranda.

The announcement is made that the Research Department of the University of Alberta has found a process by which a large proportion of the sand in the Athabasca tar sands can be removed and the bituminous residue turned into a commercial commodity for use in road-making and other purposes.

In the appendix to a paper on road problems read before the Bloemfontein meeting of the Institution of Municipal and County Engineers, Mr. D. E. Lloyd Davies gave actual accounts showing the saving in haulage costs effected by the improvement of road surfaces. The savings ranged from 14.3 per cent. in the case of a private motor car, through 16.4 per cent. for a 4-ton lorry, to 22.2 per cent. for horse-drawn traffic.

Some experiments on tungsten carried out in America by Drs. Wendt and Irion appear to confirm the fact that it decomposes into helium at high temperatures. Tungsten wires 4 cm. long by 0.036 mm. diameter were subjected to the discharge from a condenser charged by 40 ampères at 100,000 volts. The temperature attained is estimated at over 20,000 deg., and the tungsten was exploded. The spectrum of the resulting gases showed the strong yellow line of helium.

An article in the *Chemical Trade Journal* states that the real cause of the great explosion at the Oppau works of the Badische Anilin-und-Soda Fabrik has not yet been determined. The report of the experts who have investigated the matter is entirely negative, and states that nothing that was known prior to the disaster, and no knowledge that has since been gained, indicates any danger of explosion of inorganic nitrogenous fertiliser salts even in a state of fine division.

In an article contributed to *British Machine Tool Engineering*, Mr. J. D. Hope discusses the relative merits of drilling and punching holes in plates. He gives a number of actual examples, and in one plain, straightforward case says that punching would cost nearly three times as much as drilling. The impression left by the article is that drilling is generally preferable to punching, not only on account of its accuracy, but also often on account of cost.

In investigating the cause of a fire which occurred on the roof of the United States Treasury building in Washington while re-roofing work was going on, the Bureau of Standards made some experiments which show that heat transmitted downward from the oil burner of a tar heater is likely to set fire to woodwork below unless at least 6in. of insulating sand cushion is used. Even with a 6in. insulation the rise of temperature in a wooden floor under the sand cushion was dangerously high.

The largest gas engine power plant in South Africa is, according to the *South African Mining and Engineering Journal*, that of the Lonely Mine, near Buluwayo. It comprises three four-cylinder M. type Premier horizontal engines, each 368 normal and 468 maximum horse-power at sea level, coupled direct to 500-volt 50 cycles three-phase General Electric alternators, each of 250 kilowatts. A fourth three-cylinder horizontal M. type Premier engine is coupled direct to an Ingersoll-Rand Company compressor, the whole of the engines being driven from a battery of four Crossley patented wood gas plants. The cost of crushing ore has been reduced from 40s. per ton with steam plant to 30s. per ton with the gas engines.

One of the most interesting practical applications of calorisation, according to the *Chemical Trade Journal*, is the treatment of fire-bars by the Schoop process. Calorised fire-bars tested under practical conditions in various locomotives on the Prussian State Railways, it is said, lasted four times as long as ordinary bars. In the same way the grate bars of express locomotives have shown no signs of wear and tear after four months, although ordinary fire-bars have to be replaced about every six weeks. Similar satisfactory experiments have been carried out on the Danish railways. It is not very clear, however, whether the aluminium deposited by the Schoop process is as hard and resistant as that obtained by the ordinary calorisation.

The diamond drill is particularly well suited, according to the *Engineering and Mining Journal*, to deep prospecting for oil and in the drilling of producing wells, where a casing of 4in. is sufficient for production. In order to control high gas or oil pressures, when drilling or removing rods, an oil saver or packing box, provided with a series of cup leathers designed for high pressure, is used. The rods, having flush joints, pass through the packing box, making a safe, tight joint. The first producing oil well ever brought in, in any field, with the diamond drill was successfully completed last December in Mexico. It is 2153ft. in depth, and has an estimated production of 1200 barrels daily. For the first 1400ft., the ordinary rotary system, with a fish-tail bit, was used, the diamond drill penetrating the last 753ft. The hole drilled is 4in. at the top and 3½in. at the point of completion.

Some experiments carried out at the experiment station of the University of Illinois showed that in small external combustion re-heaters used in connection with compressed air plants, maximum efficiencies of from 16.7 to 61.5 per cent. may be secured, depending upon the type of re-heater employed; and that in the internal combustion re-heater of the type tested the efficiency varied from 69.4 per cent. when 326 lb. of air per hour was heated, to 83 per cent. when 1240 lb. of air per hour was heated. The tests of the engine using air as the working medium showed that under the most favourable conditions maintained the expenditure of coke per indicated horse-power per hour gained through re-heating was 0.98 lb., and, per brake horse-power per hour gained, 0.90 lb. Under the least favourable conditions of operation with cold air the mechanical efficiency of the engine fell to 59.8 per cent., while under the best conditions of operation with re-heated air the mechanical efficiency was 93.7 per cent. In the tests of the engine using a mixture of air and steam it was found that the work done per pound of mixture was considerably in excess of that attainable by the separate use of the same weight of each ingredient in the mixture.

Miscellanea.

After twelve years of inactivity, the iron mines at Atikokan, Ontario, are to be reopened.

The Chair of Mining at Birmingham University has been divided into two professorial chairs. The occupant of one of these chairs will be concerned with coal and metal mining, whilst petroleum and oil engineering will engage the exclusive attention of the occupant of the other chair.

Two Czech engineers claim to have discovered a silica which is suitable for the production of raw glass without the aid of other ingredients. The mineral is of volcanic origin, somewhat resembling lava, and as the deposits are very extensive they should provide the Czecho-Slovakia glass industry with a handy and cheap raw material.

In the course of his annual report, the South African Government Mining Engineer says that 22,475 tons of iron and steel goods were produced in the Union during the year 1921, the value of the product being £526,868, as compared with 21,988 tons of value of £538,554 during 1920. The industry gave employment to an average of 297 white persons and 803 coloured persons during the year.

Some financiers are prepared, said Mr. C. E. Fleming, in addressing the Canadian Deep Waterways and Power Association, to buy the power proposed to be developed in connection with the deepening of the St. Lawrence, at a price that will cover the cost of operation, maintenance, interest charges, and sinking funds. The price is based, he said, on the estimated cost of the project—252,000,000 dols.

The development of Japanese cotton-spinning enterprises in China is due, in the first place, to cheaper and more plentiful labour and to the supplies of raw cotton on the spot. But besides this, the proposed raising of the import duty on cotton yarn and cotton fabrics as a result of the Washington Conference is considered likely to check the importation of those goods into China, as they will not be able to compete with the domestic products. At present Japanese spinning enterprises are limited to Shanghai, Tientsin and Tsingtao, but proposals are on foot to start similar undertakings in Manchuria and other parts of China. There are at present thirty-one Japanese spinning factories in China, possessing 372,000 spindles and 2000 weaving looms, while 500,000 spindles and 1000 looms are in course of construction.

It is understood, says *Indian Engineering*, that at the end of the current year or at the beginning of next year, an experimental air survey of a portion of the Irrawaddy delta is to be carried out by the joint efforts of the Public Works, Survey and Forest Departments. The latest map of this part of the country is based on a survey taken so far back as 1869, and is admittedly inaccurate. The work of surveying, in the ordinary way, such an area, fretted as it is with innumerable creeks, is of great magnitude. Climatically and physically, the Irrawaddy delta is especially suitable for aerial survey. About 700 square miles have been selected for the experiment and the work, which will be undertaken under the direction of the Air Board of the Public Works Department of the Government of India, is expected to occupy about three weeks.

The Australian Commonwealth Government has announced its intention of expending the following amounts for providing improved services by the Postmaster-General's Department:—1922–23, £2,950,000; 1923–24, £3,660,000; and 1924–25, £3,140,000; or a total of £9,750,000. A large proportion of the expenditure will be devoted to telegraph and telephone equipment, considerable extensions and additions to automatic telephone exchanges being intended. The sum of £2,536,769 provided for in 1922–23 for telegraph and telephone works has been allocated as follows:—New telegraph lines and apparatus, including public telephone and telegraph lines to places not now connected, £199,438; telephone instruments, wire poles, insulators, &c., £530,510; additional trunks to relieve congestion, £312,952; new switchboards and extensions to existing switchboards, £628,770; pneumatic tubes, £3500; conduits and cables, £861,599; total, £2,536,769.

The American Bureau of Shipping has just announced that fuel conservation tests conducted at the request of the Shipping Board, under the supervision of a committee of marine engineering experts, during the last round trip of the United States Lines steamship America, indicate a possible saving to the Board's fleet of more than 3,000,000 dols. a year. Prior to the commencement of the outward voyage certain forms of grate bars and appliances calculated to obtain from the coal used a greater degree of combustion and heat were installed. Particular attention was given to the application of consumption of energy that is generally wasted in the form of smoke. Captain McAllister, of the America, reports that the test showed the following results:—(1) An average saving of 23 tons of coal a day, based on the record showed by the ship in eight previous voyages; (2) an average increased speed of 0.84 knots over that shown by the eight previous voyages; (3) proof that the saving in coal for the America alone would be 50,000 dols. a year.

The output of Swedish iron ore for export is approaching normal capacity, and the quantities exported have almost reached the pre-war level. The mines working for inland consumption are, to the contrary, not far from a general standstill on account of the stocks accumulated during the depression. The number of workers employed in the two groups of mines in per cent. of the total in 1913 was on August 1st about 80 and 30 respectively. The employment percentage in the ironworks has gradually advanced from 42 on September 1st, 1921, to 65 on August 1st, 1922. While only one-sixth of the blast furnaces available were operating on the latter date, about one-third of the open hearths and half of the number of Bessemer converters were working. Plants specialising in high-quality products are generally better off than the manufacturers of raw and semi-finished goods, though even among these works the distribution of orders is very uneven. In the summer the seasonal increase of the iron imports has been notable, but when compared with 1920 as well as 1921 the dumping from countries with a depreciated currency seems constantly to be losing strength.

SOME MODERN STEAM CONDENSER AUXILIARIES

W. H. ALLEN, SONS AND CO., LIMITED, BEDFORD, ENGINEERS

(*For description see page 405*)

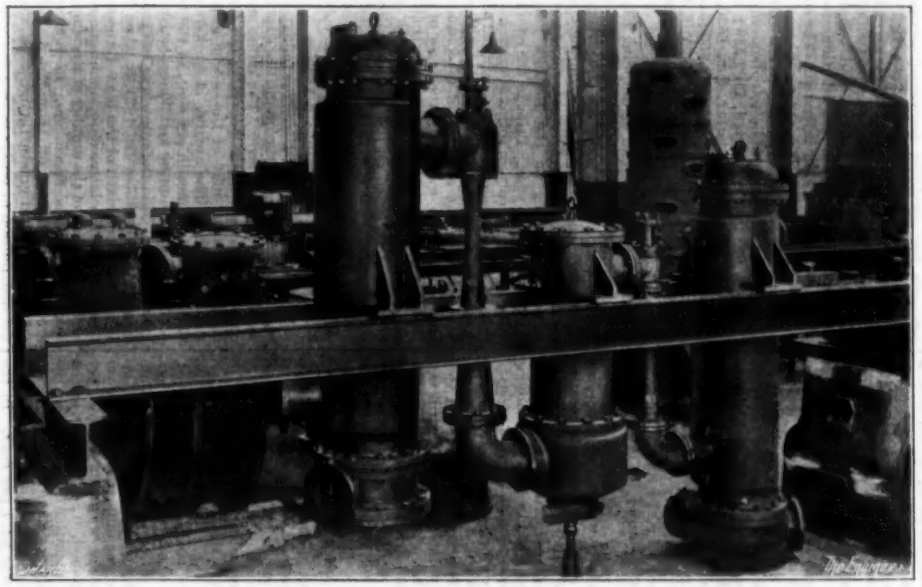


FIG. 10—MULTIPLE STEAM-JET AIR EXTRACTOR

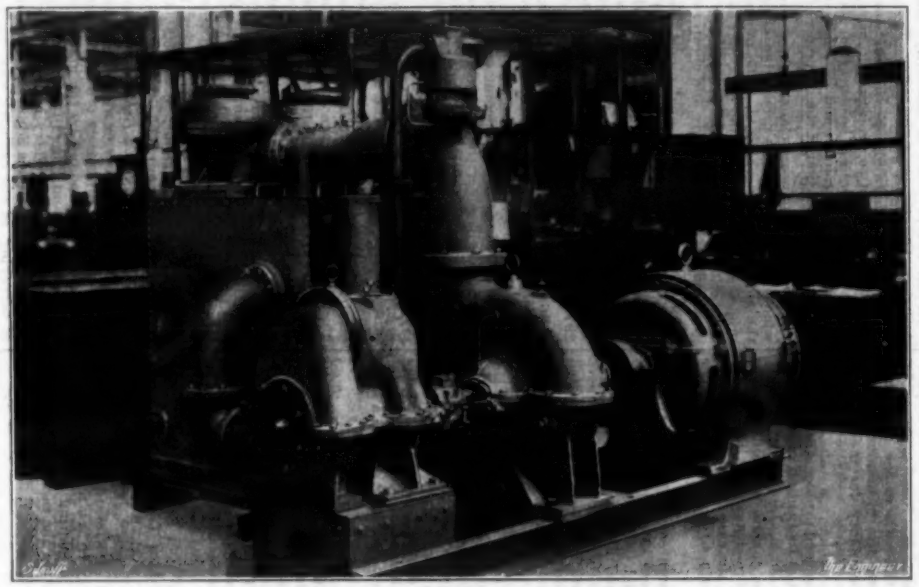


FIG. 11—MOTOR-DRIVEN, TWO-STAGE EXTRACTOR PUMP

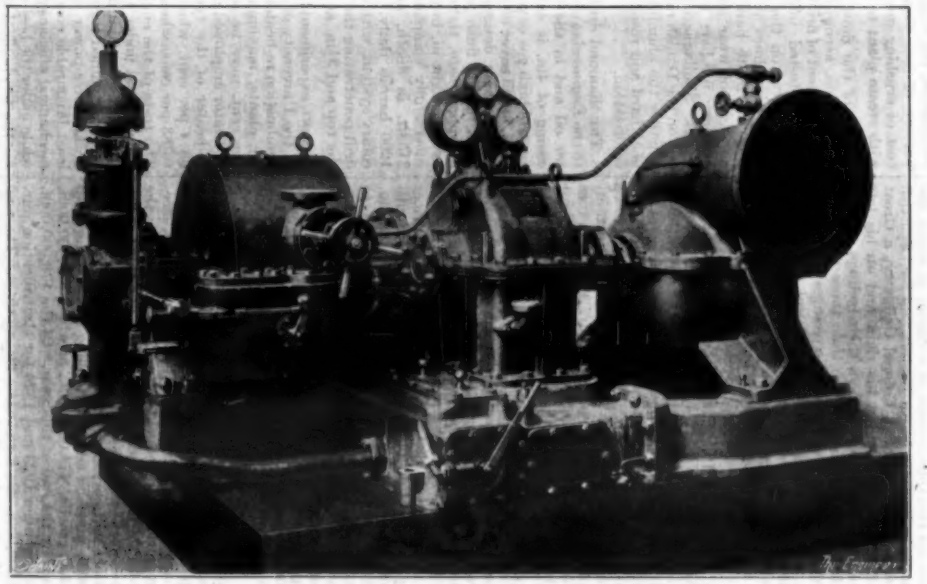


FIG. 12—TURBINE-DRIVEN CIRCULATING PUMP

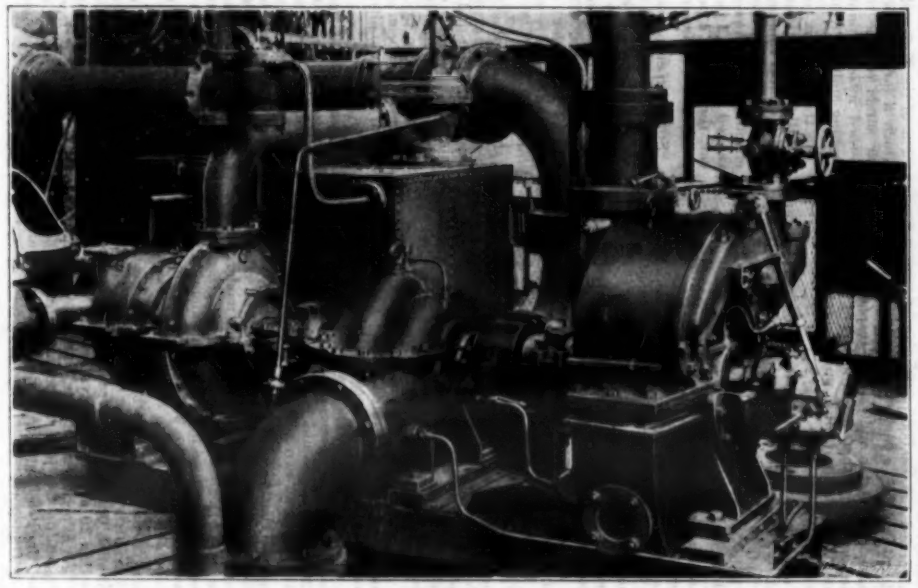


FIG. 13—SET OF TURBINE-DRIVEN EXTRACTOR PUMPS

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The Engineer

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Contents.

The Engineer, October 20th, 1922.	PAGE
The Gaseous Fluid Ejector. (Illus.)	401
Experimental Timber Preservative Station	402
Surface Condensing Plant and Auxiliaries. (Illus.)	403
The Bases of Modern Blast-furnace Practice	406
Manchester Association of Engineers	407
Electrical Markets of Peru	408
Letters to the Editor—	
Concrete Roads	408
The Brinell Ball Test	408
Railway Bridges	408
A Seven-day Journal	409
Reinforced Concrete Bridge over the River Pambayaur at Chengannur. (Illus.)	411
Blast-furnace Practice	412
The Influence of Iron on Copper and Copper Alloys	412
An Institute of Paint and Varnish Technologists	412
Railway Matters	413
Notes and Memoranda	413
Miscellanea	413
Leading Articles—	
The Student in the Factory	415
Electricity Supply	415
A Sidelight on the Battle of Jutland. (Illus.)	416
British Commercial Gas Association	417
The North Wales and Chester Electricity District	417
The Shoe and Leather Fair. No. II. (Illus.)	418
The Institution of Heating and Ventilating Engineers	419
New Floating Dry Dock for Southampton. (Illus.)	421
110,000-Volt Transformers. (Illus.)	422
Provincial Letters—	
The Midlands and Staffordshire	423
Lancashire	423
Sheffield	424
North of England	424
Scotland	425
Wales and Adjoining Counties	425
Personal and Business Announcements	425
Current Prices for Metals and Fuels	426
French Engineering Notes	427
British Patent Specifications. (Illus.)	427
Forthcoming Engagements	428
Paragraphs—	
Contracts	408
Queen's Engineering Works Association	408
Presentation at Sheffield	408
The Chelmsford Engineering Society	408
The Indian Railway Board	422
A Combustion Indicator	428
Steam Fire and Salvage Boat for Calcutta	428

THE ENGINEER.

OCTOBER 20, 1922.

The Student in the Factory.

Not many years ago professors and works managers were constantly bickering over the training of young engineers. The professors on their side charged the managers with indifference to science, adherence to the antique methods of "the rule-of-thumb," and lack of sympathy with the high aspirations of the technical school. For their part the managers retorted that the professors did not understand the needs of the workshop, that they were teaching the students things which were no use to employers, that they were inspiring in young men a contempt for workshop methods, and that they were sending out a finished product which was so "swollen-headed" that it was intolerable alike to the employer and the workmen. All that is now over. There was much truth on both sides and, as invariably happens in such cases amongst sensible people, a reasonable mean was found. The professors took the advice of the works managers and modified their curricula, and the managers agreed to employ college students as long as their own views on training were considered. Thus a happy state of affairs was established, a state of affairs which has led undoubtedly to the increase of science in the workshop and of a more useful form of education in the college.

Agreements of this kind need continual watching, for it is always possible, once criticism and opposition have been stilled, for one side or the other to enlarge its original boundaries, and by slow and insensible pressure move its neighbours' landmark. There is at present no pronounced evidence of a change of that kind, but there is visible, to those who are in a position to watch slow movements, an indication of a desire to exalt college education at the expense of workshop training. There still exist a good many engineers who depreciate the value of workshop training and—partly on account of the disturbance caused by the war—the vigilance required by our engineering societies in maintaining their regulations in this respect have had to be doubled. We number ourselves amongst the "die-hards" in this matter; indeed, we believe it to be more important than ever that workshop training for not less than three years should be insisted upon. The old reasons still hold as firmly as ever; the workshop instinct, the feeling for materials and fitness, the economic questions and the fraternisation and sympathy with the workmen themselves. These things can only be acquired in the factory. A new need for insisting upon them has sprung up with the colleges. Thirty years ago men became mechanical engineers because it was in their blood; they would rather lose money in that profession than make it in another. There were no two words about it, they *had* to be engineers. The workshop was the test; if they failed there, they failed altogether. Nowadays the position is different. A great many young men take up engineering because they, or their parents, think it is a paying profession. There is not that absorbing devotion to it that inspired men in years gone by, and whilst the youths carry on well enough through the technical schools where they find the ladder to learning made easy for them, they jib at the shops. Such men may make adequate researchers or they may do well on the business side and carry through fairly well in mass production works, but they will never be real mechanical engineers in the greater sense of the term, and they will enter the shops with an exaggerated view of the importance of their scholastic education and a disinclination to understand engineering problems from the manufacturer's standpoint. To them—because they need the advice more than born engineers—may be commended the address which Mr. Charles Day delivered at Manchester last week to a graduates' branch of the Institution of Mechanical Engineers. Mr. Day is himself a mechanical engineer of the first water, and an advanced employer. He is certainly no apostle of rule-of-thumb, and he belongs to the new school rather than to the old. The last thing in the world he would do would be to depreciate scientific education. It is because he is what he is that his advice enforces consideration. Enumerating the qualities which lead to a successful engineering career, he placed industry first. He advised young men seeking employment in engineering works not to state, in their letters of application for situations, that they desired places where their college training could be utilised, but rather to remember that what they wanted was experience of quite a different kind from what they had obtained at college. He said that probably for some years college-trained young men would be of no greater value—possibly even less—than apprentices without college training. What students needed was actual work from which experience could be gained, while what the employer wanted, in every capacity, was a willing worker. Real practical experience was essential in engineering, and the value of theoretical training was felt somewhat later in life when a position had been attained in consequence of successful work in the lower grades. He did not wish his hearers to think for one moment that he attached little value to theoretical training, but it was important to remove from the minds of young men the belief that such training was of immediate value to them in an ordinary works. The training given at our colleges was of the highest value, and without it any man was badly handicapped; but its value only began to apply when a position somewhat above that of the workman had been attained, a position which required a man to act on his own judgment.

We are confident that Mr. Day would not have spoken to the graduates as he did, did he not know from experience the necessity of such an admonition. His words, therefore, would seem to indicate that something not quite right in the attitude of the college student to the factory is again manifesting itself—in the North-West at least. If it is, then the sooner employers follow Mr. Day's lead and tell students quite plainly and clearly what their position is, and must be, in factories, the better. It would be well, too, if professors would adopt the same plan and in their addresses to students impress upon them that what employers need are industrious and keen young men whose first thought is to help the business on its way, and that during their few years in the shops they must be content to accumulate practical experience and not to feel impatient if there appears to be little call for the theoretical knowledge they have with difficulty acquired. Nothing can be more important for the progress of engineering than the maintenance of a cordial relationship between the colleges and the workshops, and it rests as much with the past students themselves as with the colleges to see that that relationship is not endangered.

Electricity Supply.

Since the task of reorganising the electricity supplies in this country was first undertaken there have been many reports on inquiries and other activities of the Electricity Commissioners. Many will be thankful when all the problems connected with the business are satisfactorily solved, and when nothing remains to be done beyond putting the various schemes into practical operation. Few things are more essential to industry and the general welfare of the community than cheap power, but it will, we fear, be long ere all

the objects aimed at are attained. The magnitude of the task with which the Electricity Commissioners are grappling is far greater than many who have criticised their progress imagine. A recently issued report of the Minister of Transport on the work done under the Electricity Supply Acts gives a good idea of the wide range of subjects which have been dealt with during the year ending on March 31st of 1922. It shows that in this period the Minister had to consider a great many applications for special orders to increase the maximum prices of current, for extensions of the time allowed for carrying out statutory duties, for permission to break up streets for the purpose of laying mains, for the erection of overhead transmission lines, and other matters which entailed consulting the Electricity Commissioners before a decision could be reached.

There were, of course, several important public inquiries into schemes associated with the reorganisation of electric supply which, together with other activities, caused the year which the report covers to be an extremely busy one. Thirty-two special orders made by the Commissioners were confirmed by the Minister of Transport, whilst the total number of applications before the Commission was seventy. The erection of three new statutory and eight non-statutory generating stations was sanctioned. Sanction was also given in six cases for the erection of overhead transmission lines, and fifty applicants have been granted permission to extend generating stations. When the proposal to reorganise the electricity supplies was first put forward it appeared to be pretty generally supposed that extensions to old generating stations would not be permitted, but it was soon seen that such a policy would, if rigidly enforced, inevitably retard the electrical industry, and extensions at a very fair number of existing stations have now been sanctioned. For the year covered by the report the authorised extensions of existing stations represents approximately 143,700 kilowatts of generating plant, whilst the initial capacity of the new generating stations amounts to about 30,660 kilowatts. No fewer than 394 applications were received by the Commissioners during the year for permission to borrow money for electricity supply undertakings. Sanction was given in 389 cases, and the total sum of these loans was no less than £13,708,385. This figure naturally only relates to local authorities, and if the expenditure of the companies—which, so far as borrowing money is concerned, are not under the direct control of the Commissioners—were taken into account, it would no doubt be found that the figure would be very substantially increased. It will be seen, then, that although the condition of the electrical industry is very far from ideal, material progress is being made, and despite the high cost of installing motors and lighting, the demand for electric current continues to increase. Among other matters dealt with in the report is the revocation of powers which in some cases were obtained seventeen or eighteen years ago, but which have remained undeveloped. In all, twelve Provisional Orders and two Acts were revoked, whilst the question of repealing eight others is under consideration. It is also satisfactory to discover that the Commissioners are giving consent for the erection of overhead transmission lines in a number of places. This relatively cheap and easy method of supplying current to rural and other out of the way places has not in the past received a great amount of favour in this country, but the time is not far distant when this form of transmission will undoubtedly be adopted on a much larger scale than hitherto. The supply of cheap electricity to the agricultural districts is a matter which electrical engineers cannot afford to ignore. From time to time much has been said and written about the advantages of electricity on the farm. It is obvious, however, that no real progress can be made in this direction until the farmers are provided with cheap current which can be conveniently supplied by means of overhead wires. One has only to witness the rapid development of this method of transmission on the Continent of Europe—in France, for example—to see the benefits that accrue and to become convinced that British fears are exaggerated. Just as one extremely costly system of railway construction has resulted in high railway charges, so will an insistence on the more costly form of transmission lines lead to charges for electricity which will be a permanent hindrance to all industries.

Although the Electricity Commissioners have been subjected to much criticism, they are undoubtedly doing their best to encourage progress and development. The work of reorganising the electricity supplies is, however, a long and laborious process. In the past there have been many mistakes which have led to much unnecessary trouble and complication. The adoption of many frequencies, for example, has proved a great drawback, and the standardisation of frequency at this stage is no easy task. One of the main things to be aimed at in connection with this work of establishing good electricity supplies is obviously to avoid fresh mistakes and the planning of the new schemes necessarily involves much investigation and thought. New and better methods of power generation are badly needed in many parts, but it is folly to suppose that the work involved in providing the improved systems can be carried out satisfactorily in haste.

The Influence of the Depth of Water on the Speed of Warships.

In an article on the influence of depth of water on the speed of ships, which appeared in our issues of March 25th, *et seq.*, 1921, it was suggested that one of the reasons which may have contributed to the wide discrepancy at the Battle of Jutland between the position of the battle-cruiser force, as given by Sir David Beatty to Lord Jellicoe, and that in which the navigating officers in the Grand Fleet almost unanimously claim that they actually found him when they did eventually meet, might have been due to the fact that on the long south-south-easterly run and back again during which the battle-cruiser action was fought the depth of water in the North Sea was such as materially to reduce the speed of the ships below that corresponding with their engine-room revolutions when these vessels were run in deeper water. We know from the official dispatches that during that portion of the action the estimated ship speed of Sir David Beatty's squadron was about 25 to 26 knots, rising to about 27 at most just before he effected the junction with the Grand Fleet and turned the head of the German line in advance of the deployment of Lord Jellicoe's fleet. We also know that battle-cruisers of the "Lion" and "Derfflinger" types, which are capable of 27 and 28 knots, do not, at these speeds, reach a depth in which they are no longer affected by the interference of the sea bed with the surface wave systems which are then propagated until they are in at least 300ft., and the battle-cruiser action took place in water varying in depth from 160ft. to 190ft.

In the last volume of the "Jahrbuch der Schiffbau Technischen Gesellschaft"—the German Institution of Naval Architects—in a paper by Herr Weitbrecht, of Stettin, on the interaction of depth and speed, resistance curves are given from a number of tank tests made on various models run in different depths. Those relating to torpedo craft add nothing to our previous knowledge of the subject, but the model tests of an armoured cruiser of dimensions corresponding to the Moltke and Goeben, of 22,600 tons displacement, are of considerable interest, and go far to confirm the practical extent of the retardation of large vessels suggested in the article referred to above. With the Moltke, as we then related, sea trials were made both on the Neukrug course in the Baltic in a depth of 200ft., and also in the Skaggerack, where very deep water is obtainable, in about 400ft., the latter depth being fully sufficient to eradicate all influence of sea bottom. In these two depths a very considerable retardation was observed on the shallower course. Both the Lion and Princess Royal made their official trials on the Polperro course in a depth of over 300ft., and Rota's experiments in the Spezzia tank show that for vessels of this class about 320ft. is the minimum depth for no further influence on resistance.

In Fig. 1 we reproduce the track of Sir David Beatty's squadron with the depth figures given on the Admiralty chart of the portion of the North Sea in which the action took place; and in Fig. 2 are shown the resistance curves of the German battle-cruiser model, as given in Herr Weitbrecht's paper, when run in water corresponding to (*a*) unlimited depth, and (*b*) in a depth of 32 m. (105ft.). The asymptotic nature of the latter curve is reproducible only in a tank. The actual power in the vessel is represented by an ordinate, the maximum value of which reaches a figure of only about 2.5 on the resistance scale corresponding to a speed of about 27.5 knots in deep water. The retardation at this point in 105ft. is no less than 3 knots! The worst depth for such a vessel at 27.5 knots would be about 75ft., while other model experiments indicate that the minimum normal depth for this speed would require to be about 320ft. The average depth of 160ft. to 180ft. would probably entail a loss of speed of at least 1½ to 1¾ knots compared with deep water.

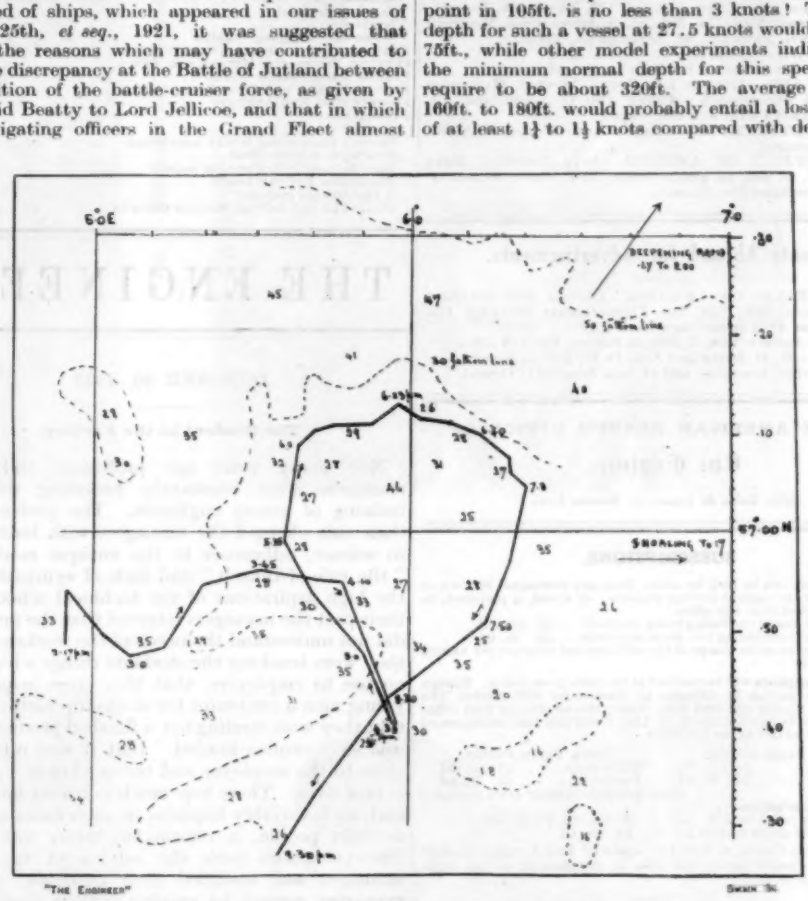


FIG. 1—TRACK OF SIR DAVID BEATTY'S SQUADRON IN THE BATTLE OF JUTLAND

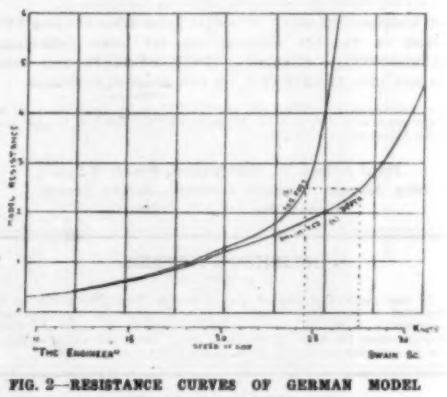


FIG. 2—RESISTANCE CURVES OF GERMAN MODEL

This amount would not be sufficient to account for the whole discrepancy in position occasioned by the report of the battle-cruisers to Lord Jellicoe; but it must undoubtedly have affected any estimate of speed made from engine revolutions, and in this way have possibly contributed to an error which involved the eventual discovery of the German fleet in a position several miles nearer to our own than the Commander-in-Chief of the Grand Fleet had been informed was the case. The net result of this discrepancy, which has never been fully explained, was that the German fleet was first sighted by the Grand Fleet on the starboard bow instead of ahead, and this involved the deployment to port instead of to star-

board, as had originally been intended, and which would have in all probability have given us a more advantageous position for the intermediate stages of the action, whereas our vessels were then between the enemy and the sun.

Referring to Fig. 1, it will be seen that when the action commenced at about 3.45 p.m. the depth of water was 168ft., and that except for a few minutes the entire action took place inside the 30-fathom line. On the return journey north, between 4.40 and 6 p.m., the depth was gradually coming down from 180ft. to 160ft., so that the ship speed calculated from engine-room revolutions would be materially less than the actual speed, and, compared with deep water, it is probably no exaggeration to suppose that the total loss of distance was a matter of 3 or 4 knots at least. The actual track shown is that of the Princess Royal. The Lion went rather further south on the same course, but the tracks are virtually identical; in that phase of the action between 6.40 and 8 p.m. the Lion was somewhat inside the Princess Royal's estimated course.

The curves in Fig. 2 are remarkable for the extent of the interference even at comparatively low speeds. Compared with deep water, the retardation is 1 knot less at 23 knots (in deep), and at 20 knots deep it is 0.6 of a knot. The power required to give 23 knots in 105ft. gives 25 knots in the unlimited depth. This condition, it must be remembered, is that shown by the tank model for the hull only; owing to the wave formation there will be slight advantages or disadvantages affecting propeller efficiency in the actual ship, but these curves clearly show that the influence in this class of ship can be very considerable, and the two diagrams taken in conjunction prove that the effect of relatively shallow water must have been experienced to a marked extent during the early part of the Battle of Jutland.

British Commercial Gas Association

Questions of considerable interest from the public and industrial standpoints have been under discussion at the annual conference of the British Commercial Gas Association at Bristol, which terminated on Wednesday last.

Scientific Basis of the "Therm."

In his presidential address, Sir George E. Davies referred to the vexed problem of charging consumers on the basis of calorific value instead of illuminating power. He claimed that the "therm" system of charging was based on scientific principles, and was devised and introduced in the interests of consumers by the Board of Trade and its technical advisers. The suggestion which had been made that heat units supplied in comparatively rich gas were of less value than those supplied in comparatively poor gas, and that therefore the "therm" had a varying value to the consumer, was not supported either by experimental work or the practical experience of large consumers, who, like railway companies, were supplied at different stations with varying qualities of gas. Within a wide range in the calorific value one heat unit was as good as another, provided that certain simple and easily effected adjustments were made in the appliances in which the gas was used. He could assert with confidence that the consumer was better protected as to quantity, quality and price in the case of gas than in that of any other commodity in general use. The outcry over big gas bills for the June quarter of 1922 was not caused by a change in the method of charging but by the cold and damp summer which induced a greater use of gas heating for domestic requirements.

Gas Fuel.

In a contribution dealing with the employment of gas fuel in industry, Mr. W. M. Mason said that gas was consumed in sixty-four primary trade processes, and there were 2706 tabulated trades in which it was employed for an average of seven processes in each. It was recognised that as a result of the research work conducted during the war period both in the manufacture of gas and in the general manufacturing processes in which gas was employed, a fund of knowledge had been accumulated and co-ordinated which had opened up new applications of gas in industry. In Birmingham alone, during one of the war years, the amount of gas sold for industrial purposes reached a total of 2680 million cubic feet. There had been during a recent period many marked developments in the use of town gas for melting, annealing, tempering, hardening, forging and welding, and for the heat treatment of metals generally. The increased use of gas in the metal and other industries was partly due to the reduction which had been made in the price when used for industrial purposes, but chiefly to the many improvements in the design and construction of furnaces, of which the advantages as compared with coal-fired furnaces were being generally recognised. Economy of space, saving of labour, better control of temperature, reduction in the percentage of spoiled material were the chief of these advantages, and they made a wide appeal.

Factory Lighting.

The use of gas for lighting factories and workshops was dealt with in a paper by Mr. Robert Watson, engineer of the Doncaster Gas Corporation Department. He reminded the conference that with gas burners of the inverted type used in groups, as in the case of reflector lamps, values of 30 to 40 candles per cubic foot were obtainable. Lamps of that type were now being used in large lighting units running up to 1000 candles for both interior and exterior illumination. Gas lighting systems had been further improved by the introduction of the superheater incandescent gas burner. In those burners the gas and air mixture was preheated during its passage through a small chamber placed immediately over the burner, the pre-heating giving a high flame temperature with greater incandescence of the mantle surface. The proportion of gas and air was governed by a simple form of regulator and the mantles used were smaller and stronger, and renewals were infrequent. With such burners 30 candles per cubic foot could be obtained under ordinary pressure, and with the reflector type of superheater burner lamp efficiencies of from 40 to 50 candles per cubic foot were claimed.

With the efficiencies which could now be guaranteed, modern gas lighting was cheap. A cluster light of two superheater burner nozzles using 5 cubic feet of gas and giving a light of 120 candles, would cost, with gas at 4s. per thousand cubic feet, only ¼d. per hour. For some requirements high-pressure gas lighting, giving extensive illumination and high foot-candle values, was worth the additional cost involved in the installation of a mechanically driven compressor. Lighting values of 60 candles per cubic foot could be obtained under high pressures. The units of light usually employed for factory illumination were 100, 150, and 300 candle-power, but lamps running up to 4000 candle-power could be obtained and were used for lighting large areas. Costs of actual installations showed that with gas at 4s. per thousand cubic feet, 1000 candle-light could be obtained for about 0.8d. per hour. That system had given considerable satisfaction to users both on the score of cost and quality of the light. Although the Home Office Departmental Committee on Factory Lighting had made certain definite recommendations on the subject of factory lighting and had laid special stress on the advisability of glare prevention, the recommendations could not be regarded as final, and much work remained to be done before the regulation of factory lighting could be established on a basis of definite legal minima for illumination. The establishment of minimum values of 3 foot-candles for fine and 5 foot-candles for very fine work was, however, already recommended, and the Committee had scheduled the nature of industries to which such a regulation should apply. In the United States statutory codes existed defining permissible illumination values for factory yards, passages and workshops classified according to the nature of the trade, and the basis of those codes was now being reviewed by the American Illuminating Engineering Society. In Great Britain it was agreed that the general standard of illumination had risen and was still rising.

The Departmental Committee, while concerned primarily with the lighting necessary to the safety and health of the workers, laid stress in its report on the economic advantage of the increased output and higher quality of work associated with good lighting. Actual cases quoted before the International Commission on Illumination showed that where the extra cost of improved lighting amounted to only 4 to 5 per cent. of the wages paid, the output had increased from 11 to 15 per cent. in many instances, and in some cases by 20, 40 and even 70 per cent. The direct method of lighting was usually employed in preference to systems in which the illumination was obtained by reflection, and was generally more economical. The charge that gas lighting had an injurious effect on health was now very seldom heard, and in any case could not apply to incandescent gas systems, which assisted ventilation and brought about sterilisation of the air. Dr. J. A. Shears, the sanitary expert of the Health Department of New York, had stated in a report just issued that the perfect combustion of illuminating gas had a highly beneficial effect on the quality of air, and that incandescent gas lighting was associated with minimum of fatigue among workers.

The discussion ranged over a wide field. Mr. Cobb said that he had never been able to realise the figure of 60 candles per cubic foot, but had obtained 52 candles. In his experience, the use of gas had been retarded by defective burners. One well-known type had no gas regulator and no air regulator. He agreed that the superheater burner constituted a most important advance on old methods. Workshop lighting was a very difficult problem, owing to the varied character of the work for which provision had to be made. He had overcome the difficulty of giving efficient local lighting by fixing a long bracket with a large radius to the wall behind the bench occupied by workmen.

Mr. Norton dealt with American experience, and detailed the results of experiments in lighting carried out by the chief engineer of the lamp division of the General Electric Company. The investigation was the outcome of a belief derived from practical experience that human sight was not continuous, but was based on a series of rapidly repeated impressions, and that inadequate illumination set up conditions of visual fatigue. Tests were conducted with printed matter moving at varying speeds under varying intensities of illumination, and it was found that there was a definite relation between the lighting and the fatigue in reading. That led to an attempt to investigate the relation of ordinary industrial fatigue and lighting, and it was found that the occurrence of a normal daily period of reduced output could be prevented by providing at that period an intensive illumination of the workshop. In most cases indeed an increase in output occurred instead of a decrease. The detailed results of these experiments, which had been in progress during the past eighteen months, would, it was hoped, be published, and made available for the use of all interested in the lighting of factories and workshops.

M. Depree referred to the difficulties which had been experienced in connection with the lighting of foundries. In the cases which had come under his notice, gas lighting had proved a failure. Trouble was caused by the presence of steam and dust, and it had been necessary to use electric lighting.

Mr. W. Wilson, who said that he had also had experience of foundry lighting by gas, said that good results had been obtained by the use of high-pressure gas on the Selas Turner system. The efficiency of high-pressure gas lighting was, he could assert, recognised by many engineers responsible for foundry work.

In the discussion on Mr. W. M. Mason's paper, Sir Arthur Duckham contended that for heating requirements in industrial operations there was no serious competitor of gas. Only by the use of gas appliances could the manufacturer obtain the heat required in many operations, particularly in the metal industries, and the temperatures which could be attained were only limited by the capacity of the refractory materials of the furnace to withstand high degrees of heating. The temperature could be had with either an oxidising or reducing atmosphere, and provided ideal heating conditions for many industries. It could not be doubted that there was an enormous field of industrial application open to the gas industry. It was, however, necessary to secure the co-operation of the gas industry with users, so that the plant might be designed for the particular object in view and the best service be given. Price considerations were of far less importance than good results, although it was obvious that with the increased use of gas in industry, the cost of the fuel and the apparatus would reach a lower level. In his opinion, the solution of the fuel problem in Great Britain would be the employment of electric energy generated by gas engines.

Dr. C. F. Walter gave a brief account of developments in the Birmingham district in the use of gas furnaces. During the period of intense demand, one large undertaking had used 100 million cubic feet of gas in a single year for the melting of aluminium. The problem in the Birmingham district was more difficult than in other great centres of industry, owing to the varied character of the manufacturing operations. The new type of Walter gas sealed-tube furnace was now being employed, and it was used, not only for heating purposes, but to prevent oxidation. It had been installed in factories at Redditch engaged in the manufacture of needles, and in Birmingham in the pen-making industry. It was hoped to arrange at the Gas Department of the Birmingham Corporation an exhibition of all types of gas-fired furnace, and to carry out tests for intending users.

The Conference was one of the most successful that the Association has held. Alderman Lloyd, of Messrs. Stewarts and Lloyd, was elected President for the ensuing year, and the next Conference is to be held in Birmingham.

THE NORTH WALES AND CHESTER ELECTRICITY DISTRICT.

On July 16th, 1920, the Electricity Commissioners provisionally determined that the area comprising the counties of Anglesey, Carnarvon, Denbigh, Flint, Merioneth and Montgomery, and parts of the counties of Cardigan, Chester and Salop should constitute a separate electricity district, and gave all parties interested an opportunity of submitting schemes for effecting an improvement in the existing organisation for the supply of electricity in the district, and including proposals for altering and adjusting the boundaries of the district and the formation of a joint electricity authority. Schemes were submitted to the Electricity Commissioners by the Corporation of Chester and the North Wales Power Company, and in February of 1921 the Commissioners held a local inquiry at Llandudno with reference to the area to be included in the proposed district and the schemes submitted. The Commissioners now give notice that they propose to hold a further local inquiry at the Assembly Room of the Town Hall, Llandudno on Tuesday, November 14th, at 10.30 a.m., and on following days if necessary, in order finally to determine the area of the proposed district. Any body or person interested may attend the inquiry or may be represented by counsel, solicitor or agent. Copies of the scheme may be obtained on application from the secretary of the Commission, at Gwydyr House, Whitehall, S.W. 1, and any representations or objections in respect to its provisions should be submitted to the secretary of the Commission not later than October 31st.

The Shoe and Leather Fair.

No. II.*

A Leather Measuring Machine.

Measuring the area of skins by means of a machine is a process presenting certain technical difficulties on account of the irregularity of the shape of the hides, the varying substance of the material to be dealt with and its elastic nature. The machine exhibited by the Turner Tanning Machinery Company, Limited, of Bramley, Leeds, operates on a new principle, which, it is stated by the makers, has so successfully overcome the difficulties met with that this type of machine has been approved by the Board of Trade for the purpose of the measurement of leather. The drawing reproduced in Fig. 7 will assist in making clear the principle upon which the machine operates and its function.

The essential mechanism consists of a power-driven feed roller A, which is provided with regularly spaced annular grooves, above which a series of friction-driven measuring wheels B are so mounted that they are free to move in a vertical direction in order to yield with the variation in substance of the material which is being measured. As will be seen from the left-hand view of the drawing reproduced in Fig. 7, each wheel is provided with a number of radially sliding pins spaced regularly at a distance of exactly 1in. apart, this distance corresponding to the distance from centre to centre of the annular grooves in the feed roller. The object of this arrangement is to divide any irregular areas into as large a number of positive units as possible, which in this case are exactly 1 square inch in area. As the material to be measured passes between the feed roller and the friction-driven pin wheels, it causes the pins to become depressed and take up a position flush with the rim of the wheel. Each pin depressed in this manner at the moment when it passes the centre line of the pin wheel and feed roller is made to engage with a star wheel C in such a way that this wheel is advanced one tooth forward. The succession of contacts between the pins and the star wheel imparts to this wheel a rotary motion which is transmitted by the attached worm shaft through a six-lead left-hand worm D to the worm wheel E. Each worm wheel is furnished with a drum of such a diameter that its circumference bears a fixed ratio to the periphery of the pin wheel.

Attached to each drum by a small clamp plate is a thin steel band some two-thousandths of an inch in thickness, which connects together the two adjacent worm wheels. The loops formed by these steel bands are passed over a number of wheels F—1in. in diameter—which, in turn, are connected to a series of integrating levers. The system of levers is so arranged that the tension caused by the movement of each of the pin wheels is passed on to the indicating mechanism. The main lever of the integrating system is supported by a steel band which moves round an accurately machined segment G, which acts as the regulator of the machine, and is mounted on the lever in such a way as to provide for its adjustment. On the left hand the top lever carries two balance weights H, and at the right-hand extremity an internal toothed segment K is attached to it, which is geared to the indicator shaft through a small pinion. When calibrating the machine by passing through it sheets having a predetermined area, the regulator may be adjusted to the right or left, by means of a micrometer screw, which alters the ratio of leverage and enables adjustment to be made, so that the dial pointer indicates the correct area. The dial is graduated to read directly in square feet and also square decimetres. The construction of the machine is such that it is influenced by changes of temperature, which, acting on the steel bands and integrating levers, cause the pointer to depart from its zero position. Means are provided on the end of the main steel band which passes round the regulator segment for returning the pointer to zero position by thumb-screw adjustments. When the machine has been accurately adjusted to a test sheet, the regulator is sealed up in order to prevent unauthorised adjustment of the machine.

After the material or a test sheet has been passed through the machine, it is necessary to return the whole mechanism to its zero position, which is accomplished by a foot treadle provided for this purpose. On depressing the foot treadle the whole series of worms are made to disengage from the worm wheels, and the balance weights on the top lever brings the mechanism automatically to its zero position. As soon as the treadle is released, the worms and worm wheels are re-engaged and the machine is ready for the next measurement to be made. A special automatic table is provided, which allows for the inequalities and the elastic nature of the hide, and allows the machine to be retarded to a certain extent to allow the longer belly portions to catch up with the shorter centre portion. This is done without imparting excessive or unnecessary stretch on the leather by the automatic table, which releases the indicating mechanism as soon as the required stretch necessary for feeding the machine has been exceeded, returning the pointer to its zero position. In this position the table is released, so that no measuring takes place, and in order to resume the measuring process the table must be re-engaged.

* No. I. appeared October 13th, 1922.

The "National" Outsole Stitching Machine.

Another interesting exhibit at the Shoe and Leather Fair was the series of new machines demonstrated by the Gimson Shoe Machinery Company, Limited, which company has works both at Leicester and Rushden. The machines we have selected for description are significant in that both the initiation of the designs and the designs themselves are in all details entirely British. As in the case of the machines dealt with in our first article, the process of manufacture is such that the parts of the machines are entirely interchangeable, special jigs and gauges being used. In the introduction to the previous article we referred to the increase of speed of stitching machines, which are now run at speeds approaching 600 revolutions per minute, or double the speed of the older machines.

The "National" outsole stitching machine—illustrated in Fig. 8—is essentially a high-speed machine embodying, we are informed, an entirely new design, all the elements of which have been thought out with the object of securing that lightness, balance and strength which is requisite for a machine capable of quick acceleration and retardation, and of running at a steady working speed of 560 revolutions per minute. It may be stated that when running at this speed it is a necessary part of the operation to stop the machine almost instantaneously, and to bring it to rest always in such a position that the work is automatically free. Special clutch mechanism is provided to attain this end. In this design the rotating cams and gearing are completely enclosed inside a protective casing in such a way that automatic lubrication may be applied to all the rapidly moving parts without risk of oil being thrown upon the work which is being operated upon. The necessary outside motions have been adapted to work through the protective casing. The various cams giving motion to the high-speed levers have carefully designed shapes, it being considered desirable by the makers to rely on cams rather than cranks or excentrics. Having regard to the complex motions of this machine and the making of the best use of the limited time allowed for any one motion or combination of motions, it has been found by them that cams are more dependable and lend themselves to better co-ordination than other forms of mechanism. The system of lubrication adopted comprises two oil supply tanks, placed above the cam shaft level, which are furnished with gravity feeds delivering oil to the principal bearings, while the cam races are lubricated by means of felt pads, which also receive oil from the supply tanks. The surplus oil is entrained in the bottom of the casing, and after filtration it is automatically returned to the supply tanks.

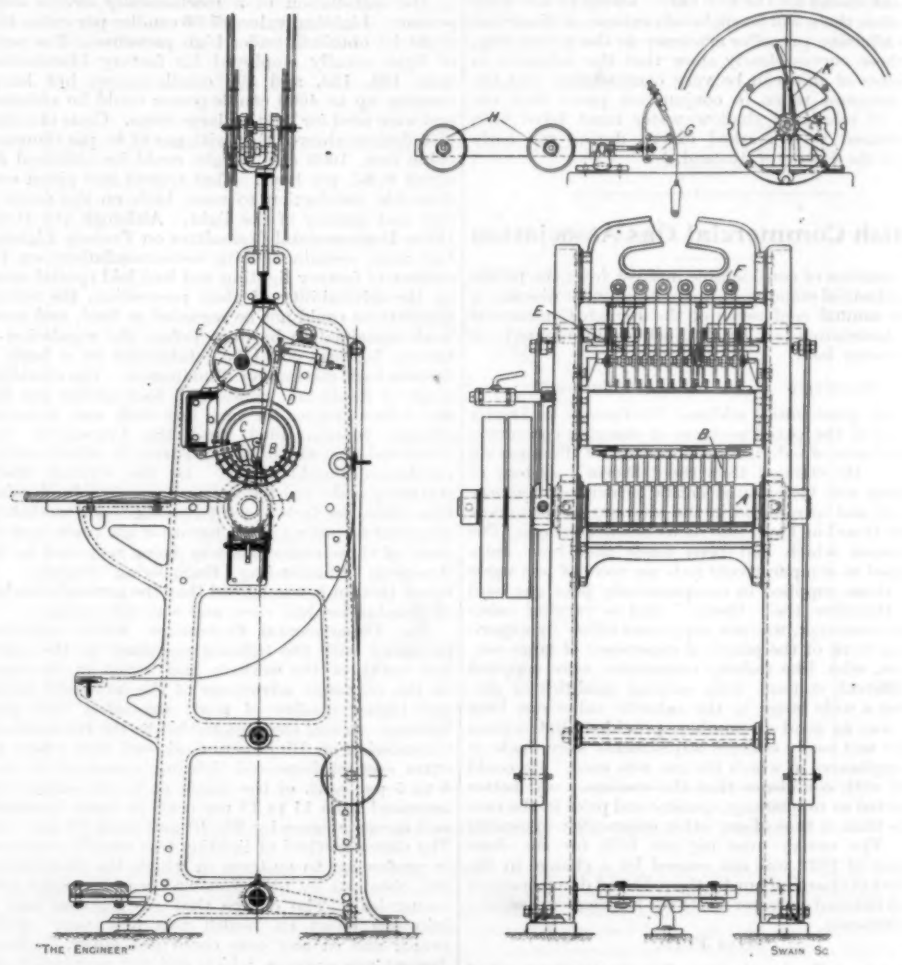


FIG. 7—LEATHER MEASURING MACHINE

The "National" Pulling-over Machine.

The machine illustrated in Fig. 9 performs the same operation as the machine described in our previous article, but in this case the actual pull on the upper of the boot, which ensures correct positioning on the last, is obtained by power through a friction clutch, which is directly controlled by a treadle. In the machine previously described, there was a direct mechanical pull through yielding devices, while other types of machine utilise a direct pull by treadle only, no power being used. The makers of this machine hold that the friction clutch pull enables the operator to use his skill to the best advantage in completing what is admittedly the most delicate operation in the making of a boot or shoe, while, on the other hand, he is not called upon to exert considerable pressure on a long-range treadle many hundred times a day.

The friction clutch is provided with ball thrusts, and the leverage of the treadle is designed so that a perfectly graduated pull is obtained, enabling the lightest and most flexible upper to be brought down on to the most difficult last. The design, we understand, possesses new features, and embodies a very complete set of adjustments. The tack-feeding mechanism calls for mention, there being no duplication of dividers for each tack shoot, but only one, which delivers into all the shoots as they are passed below it by the action of the machine. The construction is robust, and care has been taken with a view to making the necessary complicated mechanism as nearly foolproof as possible.

A Sole Evening and Grading Machine.

This machine, an engraving of which we reproduce in Fig. 10, consists essentially of a system of rollers, comprising an upper and a lower set, the former yielding upon presentation of the work, whilst the latter are knurled and impart the feeding motion. The motion of the upper rollers is transferred to a grading arm or lever, the free end of which takes up a position which is dependent upon the thickness of the leather, and is so controlled that its ultimate position corresponds to the thinnest part of the leather sole to be measured and cut. In this design of machine the free end of the grading arm is really "free," so that it can move without coming into contact with or transferring its motion to other elements. When it has taken up its final position, a second quadrant piece is brought into contact with its end, in such a way that the point at which the contact is made determines the setting of the rollers in that part of the machine in which the leather is

fed past the evening knife, also the movement of the marking device which prints the thickness on the sole as it passes through the machine. The sole or other leather article is stopped while the process of marking is being done, which is a new method, and the machine is provided with a gate which ensures entry at the correct time, and permits of twenty pieces per minute being dealt with.

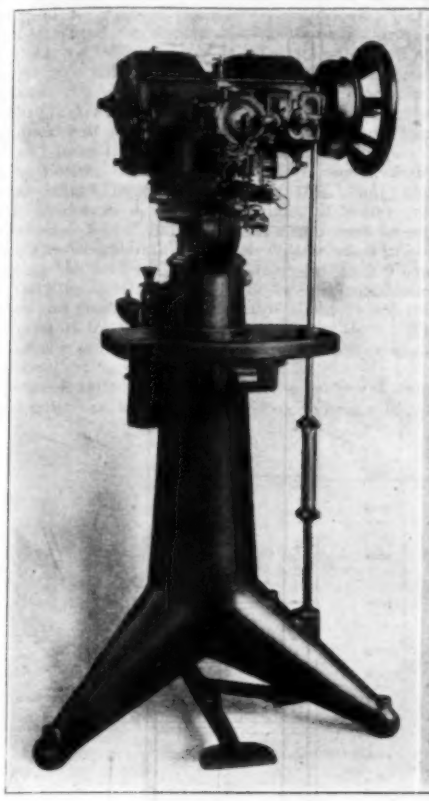


FIG. 8—HIGH-SPEED STITCHER

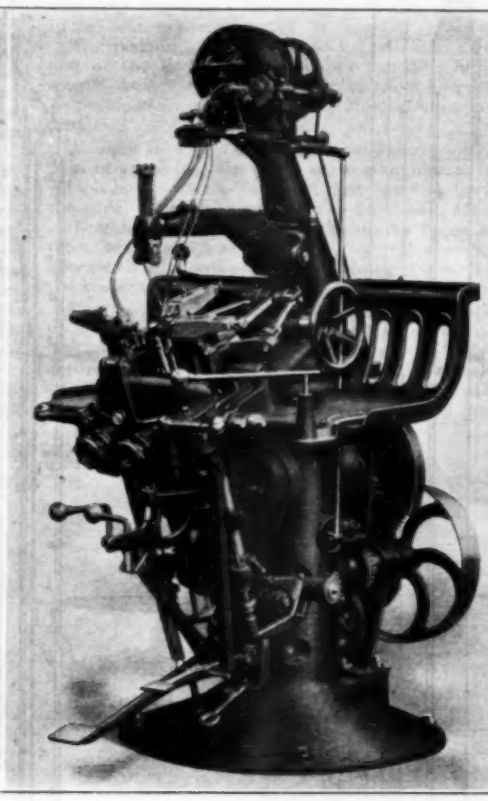


FIG. 9—THE "NATIONAL" PULLING-OVER MACHINE

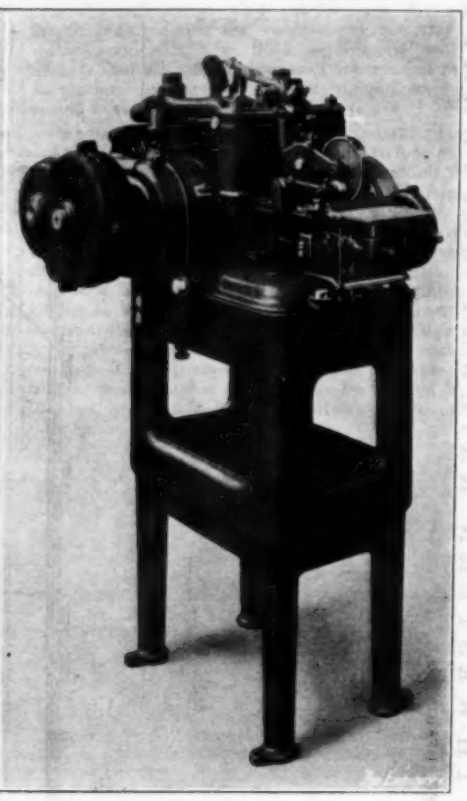


FIG. 10—SOLE EVENING MACHINE

A Direct Pressure Sole Leveller.

In this design of machine, which is used for sewn and stitched work, a metal form carries the boot, and is mounted on a rocking shaft in such a way that it is automatically presented to another form carrying the contour desired, after which the pressure is applied. There are two forms, which are so arranged that while one is under pressure, the other is in the upright position shown in Fig. 11, which enables the work to be changed. The system of relief springs which is employed is capable of adjustment for pressures varying from 3 to 8 tons. The design of this machine is characterised by its simplicity and strength, and the worm drive is fitted with ball thrust bearings, the drive and excentric shaft being neatly contained in the main casting of the machine, the motion being conveyed by heavy rocking beams. A very high pressure can be obtained, and the range of pressure is very considerable.

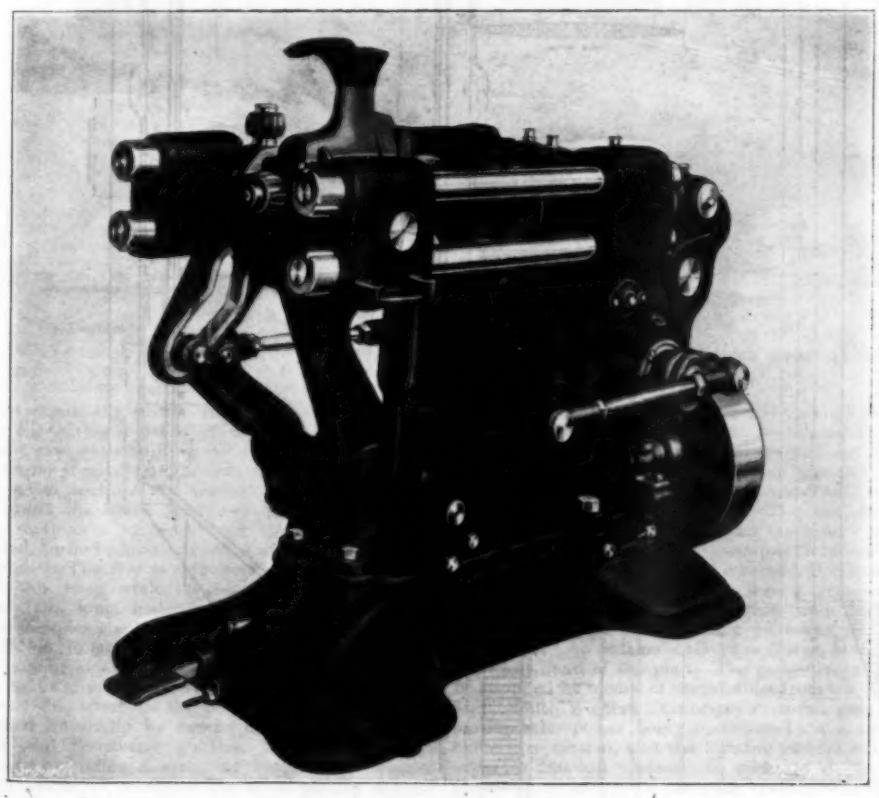


FIG. 11—DIRECT PRESSURE SOLE LEVELLER

Finishing Machinery.

A large number of finishing machines were shown by the Standard Shoe Machinery Company, Limited, of Leicester, which firm also demonstrated a complete range of boot and shoe machinery. Whitfield, Hodgson and Brough, Limited, of Kettering, and Keats and Bexon, of Stafford, showed finishing machinery suitable for both manufacturers and repairers. Such machines are largely used by co-operative societies and large repairing establishments, and they generally consist of a combination machine in which a series of scourers, edge setters, and buffing and polishing devices are grouped together, the machines being designed for both power or treadle operation.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.

The autumn general meetings of the Institution of Heating and Ventilating Engineers took place last week, when two papers were read. On the evening of the 10th inst., Mr. Robert Fortune, Barrister-at-Law, presented a paper on "Some Points in the Law of Heating Engineers' Contracts." Mr. Fortune dealt with the position of a heating engineer employed by the building owner or his architect to supervise the installation of a heating apparatus as a part of a general building or on a given site. The position of the engineer, his authority, powers and responsibilities, were discussed, and the guiding principles of law underlying some of the main questions which have to be dealt with were illustrated from actual cases.

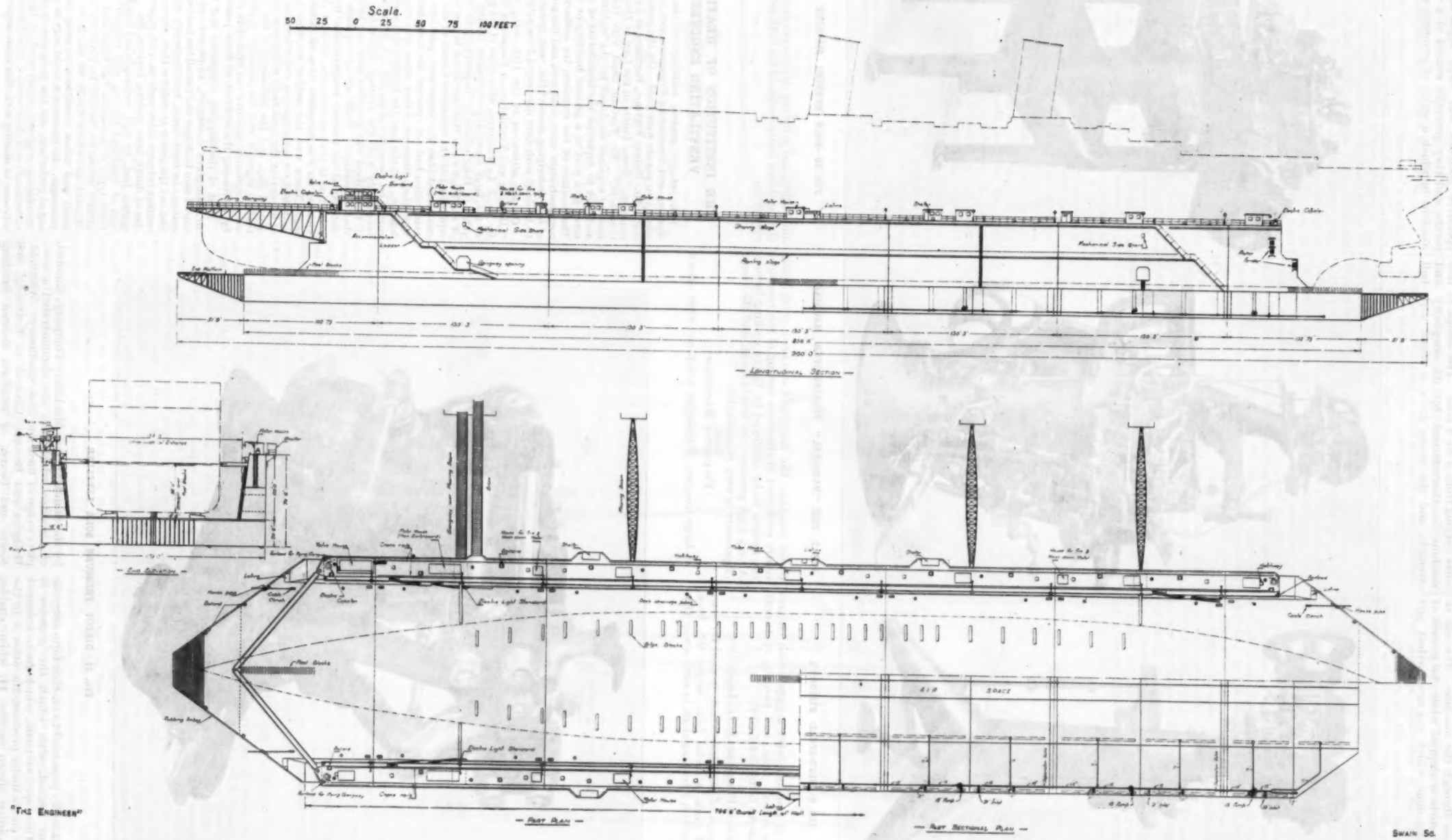
On the afternoon of the 11th inst., a paper on the "Heating and Ventilation of Passenger Ships," was read by Mr. J. L. Musgrave, who spoke of the progressive spirit of the large steamship companies during the last twenty years in their efforts to improve ocean travel. In spite of the huge sums that are spent in the construction and equipment of the luxurious vessels of the present day, he considered that the important questions of heating and ventilation had not received the consideration and attention they deserved either from the owner, designer or builder. At the best the heating and ventilating arrangements on passenger ships did not, he said, compare at all favourably with the average important building, which in these days was provided with the latest equipment in these directions; fresh air of requisite humidity being distributed at various temperatures to different parts according to the requirements, while at the same time the vitiated air was extracted from all portions of the building. There was, the author contended, undoubtedly a vast field for investigation and enterprise in the direction of improving the conditions which now generally obtained aboard ship, and the assistance of the heating and ventilating engineer and the scientific application of his art would certainly improve the amenities of passenger ships by increasing the comfort of both passengers and crew.

Most of the shipping companies and the shipbuilders, Mr. Musgrave continued, employed capable and experienced men to design and install the heating and ventilating systems in their boats, but frequently those so employed had not the power to enforce their views in the event of a conflict between other sections with regard to space claims, size of ducts, fans, motors, heaters, &c. The thermo-tank system had, he said, accomplished much in the application of combined heating and ventilation to ships, and other types of apparatus had been used with success, but greater attention should be given to the extraction of vitiated air, which would do much to remove the ship smell and other conditions causing discomfort to the passenger. Improvement could only be obtained by aiming at perfection, and the co-operation of the heating and ventilating engineer experienced in the principle of air movements and their control would secure a considerable advance in dealing with this most important problem.

60,000-TON FLOATING DOCK FOR THE LONDON AND SOUTH-WESTERN RAILWAY, SOUTHAMPTON

MESSRS. CLARK AND STANFIELD, WESTMINSTER, DESIGNERS

(For description see opposite page)



New Floating Dry Dock for Southampton.

Through the courtesy of Sir Herbert Walker, K.C.B., the general manager of the London and South-Western Railway Company, and of the engineers and designers of the new floating dock which is to be provided for Southampton, Messrs. Clark and Stanfield, of Victoria-street, Westminster, we are able to give some further details of this important structure, the contract for which has been placed with Sir W. G. Armstrong, Whitworth and Co., Limited. The dock will be built at High Walker-upon-Tyne, and will have the following principal dimensions:—Lifting power, 60,000 tons; overall length, 960ft.; overall height of the side walls, 70ft. 6in.; clear width of entrance, 134ft.; draught of water over keel blocks, 38ft.; depth of water required at site, 65ft. The weight of steel which will be used in constructing the hull is estimated at about 16,200 tons, and, adding to this the weight of the machinery, fittings and timber, a net weight of about 18,000 tons is arrived at for the completely equipped dock. The area of the pontoon is 142,000 square feet or about 3¼ acres.

The dock is to be of the double-sided self-docking type known as the "sectional box type." It will consist essentially of the main pontoon, which will form the lifting portion of the dock, and of two parallel side walls built on the pontoon so as to form one whole structure. The structure will be divided into seven sections by vertical joints, which will run round the whole profile of the dock. Each of these sections is to be so built that it may be uncoupled, turned round and self-docked on to the main structure. The five middle sections are each to be 130ft. 3in. long, while the two end sections will be 102ft. 7½in. long, making a total length of 960ft., which includes the two end platforms, each of which is 51ft. 9in. in length. The pontoon is to be provided with a central air space, and for stability purposes it is to be divided transversely into four compartments. The whole of the pontoon structure will be stiffened internally by means of longitudinal bulkheads and transverse guiders, while between the transverse guiders a series of longitudinal frames, which will serve to stiffen the stern plating against water pressure, will be run. The bottom of the pontoon is so designed that it will have a camber from the centre towards the sides, and the deck, which is parallel to the bottom plating, will have a similar camber, the centre portion of the deck and bottom being kept horizontal at the centre for a width of a few feet. Shallow troughs will be fitted on the underside of the pontoon at each pumping division, so as to facilitate the complete withdrawal of the water from any compartment. Means will also be provided for draining the deck through pipes placed at the sides of the pontoon, which will allow surface water to pass out at the back of the side walls. The deck will also be provided with manhole covers, certain of which will be fitted with plugs for sounding purposes. Mud doors will also be formed in the bottom plating.

The platforms, which are to be provided at each end of the dock, will be plated for 27ft. of their length, and the remaining part of their length will be provided with timber decking supported on lattice girders.

As may be seen from the sectional elevations and plan of the dock, the walls are rectangular in plan with a batter on the face and they are cut down at the ends. The keel blocks are to be of oak, 4ft. 6in. in height, while the bilge blocks are to be of pitch pine, with mild steel bases. Powerful electrically operated side shores are to be so arranged as to centre the vessel on the keel blocks.

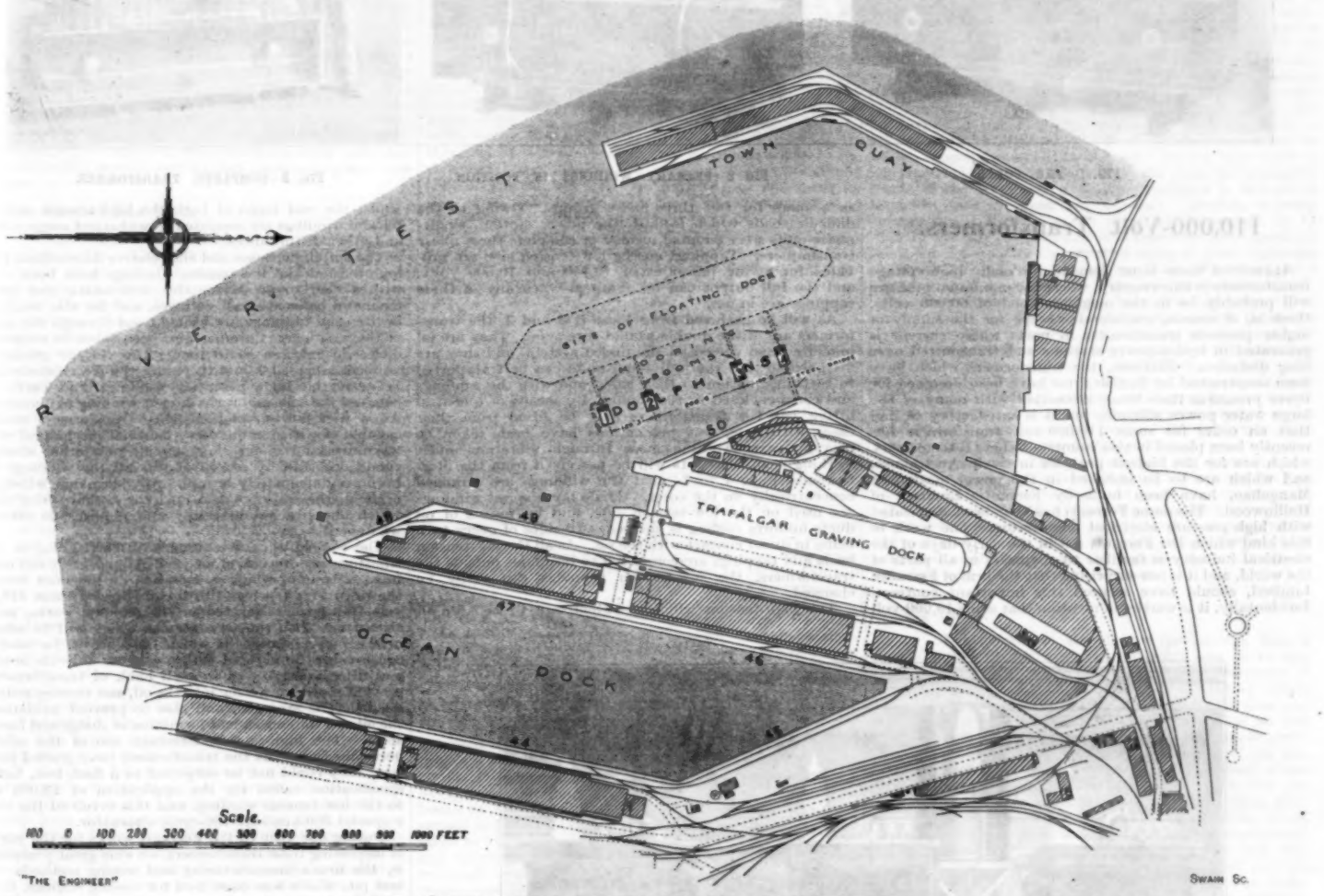
The design of the dock is such that it is to be capable of lifting a ship of 52,500 tons displacement and of 32ft. 9in. mean draught in four hours. In order to accomplish this work in that time, it will be necessary to pump out about 80,000 tons of water. The pumping machinery will comprise fourteen vertical spindle type centrifugal pumps, each driven by an independent motor. The ten pumps for the middle section will have 18in. deliveries, and will be driven by 130 horse-power motors, while the four pumps for the end section will have 15in. deliveries, and will be driven by 95 horse-power motors. The total electrical power required for the pumping machinery will be about 1250 kilowatts. Each pump is to be arranged to empty the one half section on which it is installed, but all the pumps on one side will be so grouped that they can draw from a common main drain, so that if one breaks down the work can be taken up by its neighbour. An outline of the pipe system is shown in the right-hand of the plan. The power required will be supplied by means of shore cables from the London and South-Western Company's own generating station, the power being distributed on a 480-volt three-wire system, and the lighting carried out by a separate 240-volt system. In addition to the main pumps, four additional pumping systems will be provided for the washing down and fire services.

A feature of the dock is the centralised control, which places the whole of the dock machinery under the supervision of a single dockmaster. All the motors driving the main pumps will be started and stopped from the control station by means of a push button remote control system. The compartment valves will also be controlled from this station through an electro-pneumatic system. The control station will be situated in the valve house at one end of the starboard wall of the dock, and in it the various level gauges, which equipment will include an optical and a liquid deflection indicator, will be fixed.

Additional services are the electrically driven air ejectors—six of which are to be fitted, one for each pair of small pumps, and one for each of the three larger pumps—and the compressed air and fresh water services. The dock equipment will also include shelters and latrines and other usual fittings. At the bow end there will be a flying gangway, giving access from one wall to the other.

As shown in the accompanying harbour plan, the dock will be attached on the shore side to four mooring booms of lattice construction, each of which will be 110ft. between centres. The booms will be furnished at each end with a universal joist of cast steel, which will allow the necessary freedom of movement for the dock, which is to be strengthened to withstand the push and pull of these booms. Longitudinally, the dock will be moored by means of anchors and chains in the usual manner, four open hawse pipes and four cable clenches suitable for 3½ stud link cable being provided at the dock ends. The four reinforced concrete dolphins shown attached to the ends of the booms in the above plan are to be erected by the London and South-Western railway to the design of their docks engineer, Mr. F. E. Wentworth-Shields, M. Inst. C.E., who will also be responsible for the whole of the shore work connected with the dredging and preparation of the site to receive the dock. As shown in the above drawing, one of these dolphins will be connected to the shore by means of a bridge, which will lead from it on to the dock, so that access to the shore will be possible at all times.

When completed this dock will be the largest floating dry dock in existence, and will be capable of docking the largest ships afloat, including the liner Majestic, which vessel is shown in outline in the general arrangement of the dock which we reproduce on the opposite page.



MAP SHOWING SITE OF NEW FLOATING DOCK AT SOUTHAMPTON

The provision by the Pullman Car Company of use of its cars for the Caledonian and London, Brighton and South Coast railways reminds us that this arrangement is very advantageous to the companies. The companies have not, for instance, to provide capital for the construction; the number of cars can be temporarily increased to meet any special event by transfer from other lines, whilst an important factor is that, not being railway servants, the attendants, chefs, &c., are not subject to the eight hours' day. According to the recently issued Railway Returns for 1921 there were at the end of last year 126 Pullman cars on our railways.

110,000-VOLT ELECTRIC TRANSFORMER

FERRANTI, LIMITED, HOLLINWOOD, NEAR MANCHESTER, ENGINEERS

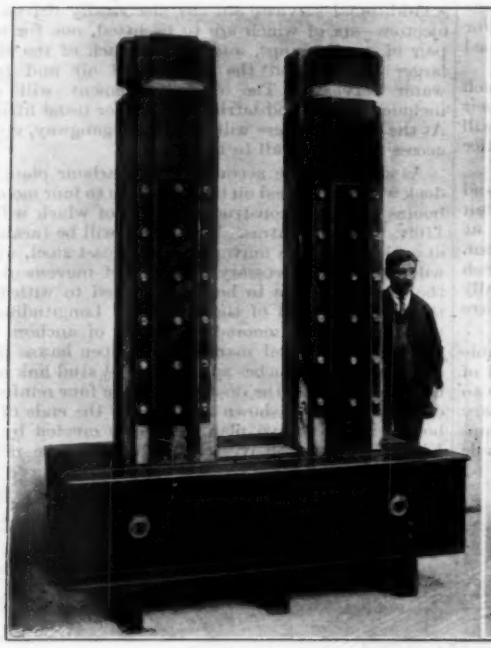


FIG. 1—THE CORES

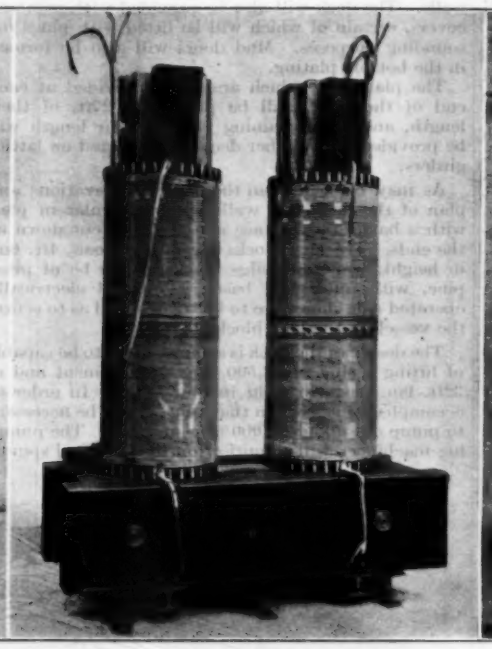


FIG. 2—PRIMARY WINDINGS IN POSITION

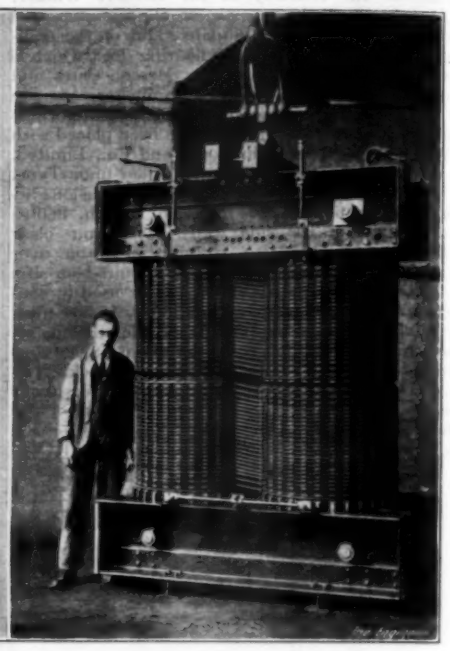


FIG. 3—COMPLETE TRANSFORMER

110,000-Volt Transformers.

ALTHOUGH there is no demand for really high-voltage transformers in this country, where the maximum pressure will probably be in the neighbourhood of 66,000 volts, there is, of course, considerable scope for the supply of higher pressure transformers in parts where current is generated in hydro-power stations and transmitted over long distances. Hitherto, the transformers which have been constructed by British firms have been designed for lower pressures than those associated with many of the large water power schemes, but it is satisfactory to find that an order for some 110,000-volt transformers has recently been placed in this country. These transformers, which are for the highest pressure in use in Australasia, and which are to be installed in the power station at Mangahao, have been built by Ferranti, Limited, of Hollinwood. The name Ferranti has long been associated with high-pressure electrical engineering. The work of this kind which Dr. Ferranti did in the early days of the electrical industry is familiar to engineers in all parts of the world, and it is not surprising that the firm of Ferranti, Limited, should have secured this important contract. Incidentally, it is worthy of mention that some 10,000-volt to 2500-volt Ferranti transformers which were installed in the Cockspur-street sub-station of the London Electric Supply Corporation in 1891 are still in successful operation.

The Mangahao 110,000-volt transformers, which we have recently had an opportunity of inspecting at the makers' works at Hollinwood, are the first of the kind to be built in England, and they are to be used for raising the bus-bar pressure of 11,000 volts to 110,000 volts for transmission purposes. Each group of these transformers consists of three single-phase 4000-kilowatt units connected in delta on the low-tension side and star on the high-tension side, the total capacity of each group being 12,000 kilovolt-ampères. In all seven of these single-phase units are being supplied, and the odd unit serves as a spare for two three-phase groups. Owing to the difficult roads which lead to the power station, single-phase units were adopted instead of complete three-phase transformers. Tappings on the low-tension side are provided for giving pressures of 10,750 and 10,500 volts, and the full output can be obtained when any of these tappings are in use.

As will be gathered from Figs. 1, 2 and 3, the transformers are of the double-wound core type. They are oil immersed and cooled on the forced system, and they are designed so that the individual units can be transported to their destination on their sides, and with the windings and cores enclosed in the tanks. By means of a central lifting bar the transformers may be lifted from their cases with ease, but precautions have been taken to prevent parts working loose through vibration under working conditions. It will be perceived from the illustrations—Figs. 1 to 3—that the windings are arranged concentrically on the cores. Single layer spiral windings are used on the low-tension side, and by means of oil ducts uniform cooling is ensured, two sides of every turn being in direct contact with the oil. As all the low-tension leads and tappings are connected to terminals outside the transformers, the low-tension tappings can easily be changed.

The high-tension windings, which are to be seen in Fig. 3, are composed of disc coils with a single turn per layer, a form of construction which reduces the voltage stress between turns to a minimum. Between the sections there are radial ducts, through which the cooling oil circulates and makes direct contact with every turn in the coil. In the design of the windings every endeavour has been made to ensure uniform cooling throughout. The oil ducts are proportioned and disposed in relation to one another, so that the oil circulation is maintained constant, and so that uniform cooling is secured and local hot spots and dangerous temperature gradients are avoided. The insulation is also designed with a view to avoiding all possibilities of creepage along the surfaces and through the insulation in the direction of the lamination, whilst the end turns of both the high-tension and low-tension windings are insulated to withstand surge voltages and other disturbances.

The coil dimensions and the relative dispositions of the high-tension and low-tension windings have been chosen with a view to preserving the electrostatic and electro-magnetic balance at all voltages, and for this reason the low-tension tappings are brought out through the middle of the windings. Care has also been taken to control the dielectric field, so as to render the voltage gradient as uniform as possible and to reduce the electrostatic stress between the high potential windings and earth and between the coils and turns of each winding to a minimum. As is well known, high-capacity transformers must be capable of withstanding very material mechanical shocks when working under short circuit and other abnormal conditions, and by reason of this all the windings have been very adequately braced. Any shrinkage which may occur in the coils is taken up by a special spring device which operates automatically and requires no attention whatever.

The cooling apparatus used with each group of these transformers consists of a cooler and motor-driven centrifugal oil pump, which is mounted at the floor level, as shown in Fig. 4, which illustrates three of these 110,000-volt transformers erected in the makers' works, and in accordance with the arrangement which will be adopted in the power station in which they are to be used. A conservator tank fitted with a calcium chloride breather and drier is connected to each bank of transformers to prevent moisture getting into the oil, and thereby reducing its dielectric strength, and also to prevent oxidation of the oil and the consequent formation of sludge and harmful acids. The high-tension terminals are of the oil-filled porcelain type. As the transformers have graded insulation, they could not be subjected to a flash test, but the specification called for the application of 23,000 volts to the low-tension winding, and this involved the use of a special 500-kilowatt 100-cycle alternator.

During our visit to the Ferranti works for the purpose of inspecting these transformers, we were greatly impressed by the firm's manufacturing and testing methods. The test pit, which was once used for testing engines, is now used for testing transformers, and serves admirably for the purpose, for whilst the transformer tanks are well below the floor level, the tops of the transformers are in a position where they can easily be reached. Much might be written upon the firm's meter departments, in which about 70 per cent. of the electricity meters used in this country are produced, but as the object of our visit was to inspect the 110,000-volt Mangahao transformers we must leave the meter side of the firm's business for another occasion.

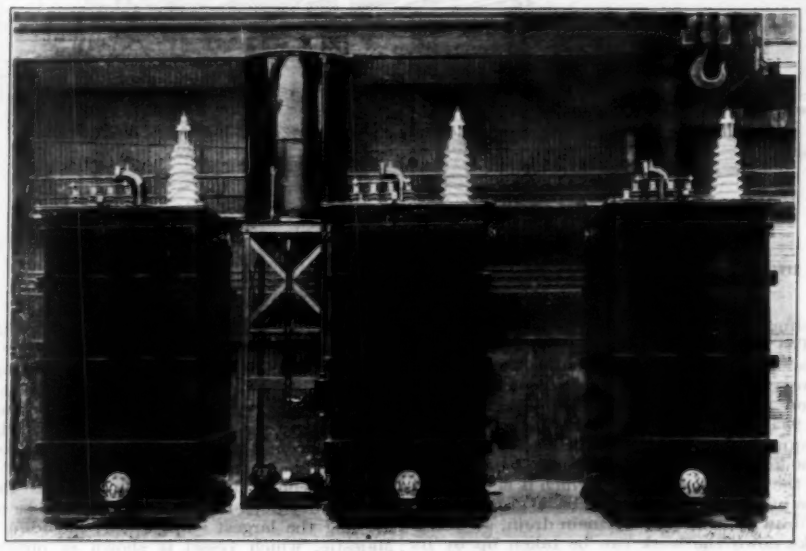


FIG. 4—GROUP OF TRANSFORMERS

THE INDIAN RAILWAY BOARD.—The Acworth Committee recommended that the Indian Railway Board be replaced by a Railway Commission, with a technical railway man as Chief Commissioner, who would be responsible, under the Member (for Communications) in Council, for arriving at decisions on technical questions, and who would have the status of a Secretary to Government. The Chief Commissioner was to have under him a Commissioner for Finance (finance, statistics, secretariat, establishments, &c.) and three Divisional Commissioners. The first step towards the adoption of this recommendation has now been taken by the appointment as Chief Commissioner of Mr. C. D. M. Hindley, now the Chairman of Commissioners for the Port of Calcutta, and, until last year, the agent of the East Indian Railway. Mr. Hindley enters upon his new duties on November 1st, when the present President of the Railway Board—Colonel W. D. Waghorn—becomes one of the ordinary members. On January 1st Mr. F. W. Hanson, the Financial Member of the Railway Board, will retire, and Colonel Waghorn and Mr. Bell will remain in office until Mr. Hindley has had an opportunity to submit his proposals as to the four Commissioners and the six Directors—of Accounts, Civil Engineering, Mechanical Engineering, Traffic (operating), Traffic (commercial), and of Ports, Inland Navigation and Road Transport—and these proposals have been approved by the Government.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The General Situation.

THE more hopeful feeling in iron and steel and engineering circles in this district, which made itself felt at the quarterly meeting last week continues. The monthly return issued by the National Federation of Iron and Steel Manufacturers is regarded as further evidence of the upward movement of business. This shows an output of pig iron during September amounting to 430,300 tons, or 18,600 tons more than August, and representing the highest output since February last year. During the month thirteen additional furnaces were re-lighted, chiefly in Scotland. It is recognised that this pig iron expansion is largely due to the American demand. But the duty of 75 cents lately imposed is not expected to check the sales of British iron to America, and other furnaces, it is stated, are being got ready for re-lighting in the expectation of expanding business for the rest of the year. The production of steel ingots and castings during the month was 555,900 tons, the highest figure recorded since December, 1920. This, of course, represents genuine business, having no relation to the American need for raw material, which necessarily must be temporary. The improved sentiment is also partly attributable to the brightening of the political situation in the Near East, which has encouraged some rebound from the pessimism which has prevailed. Though it must be admitted that at the moment orders are scarce, and that the position has not been much improved by the quarterly meeting, the general disposition is to take a hopeful view. Some of the local mills have rather more orders on their books again. In the present condition of the market it is impossible to see far into the future. Traders dare not take greater risks than they have been taking, but they realise that the volume of trade to-day, unsatisfactory though it is, compares favourably with that of three or four months ago, so that there is no ground for despair.

The Finished Iron Trade.

The Staffordshire finished iron trade is not discernibly better. The makers of best iron appear to be moderately employed, but concerns producing medium qualities are very badly off for work. Orders are decidedly small, but the trade will be assisted by some buying by warehousemen, who appear to think that the time has arrived to renew their stocks. There was a general expectation, as recorded last week, that at the quarterly meeting marked bars would be reduced, in view of the steady fall in unmarked material, and the rather wide gap between the two qualities which has been created. Unmarked bars have deteriorated during the past quarter. Values have receded about half a crown per ton in nut and bolt qualities and more in merchant bars. The latter are now in the neighbourhood of £10 10s. to £10 15s., thereby increasing the disparity between this class of iron and marked bars, which have been uninterruptedly upheld at £13 10s. since the beginning of April. In normal times 30s. per ton is regarded as the proper disparity, but the fight for orders for low-grade bars, coupled with the competition from outside, to which the marked bar mills are not subjected, has forced down values. Best iron makers, however, did not see their way to make any change, and in their view prices should be advanced rather than reduced. Millowners say the profit margin is narrow, and as they see no likelihood of stimulating demand by any reduction which could conceivably be made, they prefer to leave the price alone. Mills are receiving little support from the nut and bolt trade just now. Competition has so lowered steel prices that steel bars at about £8 15s. are being used instead of iron at £9 15s. This applies where furnaces are adapted for steel. Fencing iron is in fairly regular demand at £9 17s. 6d. to £10. Belgium has recovered a certain ascendancy in the bar trade during the past quarter. Consignments of bar for the nut and bolt trade are coming into the Black Country from Antwerp at something like £8 7s. 6d. per ton delivered. The home price for both Staffordshire and Lancashire products is £9 15s., with £9 17s. 6d. as a maximum, so that the temptation to purchase abroad is strong, especially in cases where pressure for delivery does not exist.

Changeable Sheet Prices.

Makers of galvanised sheets report that trade is not in a robust condition, but promising orders are coming to hand from Japan, Australia, the Argentine and some other markets. Once again prices have moved and galvanised corrugateds of 24 gauge are this week back to £16 5s. f.o.b. Liverpool. While there are offers of sheets at this price, quotations run up to £16 10s. and even higher, and makers say that they are able to do business on that basis. Thinner gauges in view of the better demand are relatively dearer.

Pig Iron and Coke Values.

The situation in the pig iron industry continues discouraging. While consumers are urging the necessity for further relief in selling prices, smelters are being forced to pay something like 3s. more per ton for their coke. There is a brisk demand for coke from Germany and other parts of Europe, and the suppliers are exploiting the advantage for all it is worth. Coke which could be bought at 17s. a few months ago is now held for 20s. Furnace coke is getting scarce, and it is considered quite possible that further advances on the rise of 3s. already declared may take effect. The continued American demand for pig iron which is considered largely responsible for the additional furnaces being brought into work during the past month, tends to keep pig iron prices firm. That movement, moreover, promises to continue for some time in spite of the tariff of 75 cents per ton recently imposed. This district benefits more indirectly than directly from this foreign demand, and a certain amount of Scotch business has been captured by Midland furnaces in competition with the North-East Coast, owing to the lower Midland prices. The firmness of pig iron is considered a very hopeful feature, but there is still a want of confidence. Values have undergone no change during the week, and stand as follow:—Derbyshire forge, 72s. 6d.; No. 3 foundry, 82s. 6d.; Northamptonshire forge, 70s. to 71s.; foundry, 80s.; North Staffordshire forge, 72s. 6d.; and No. 3 foundry, 84s. In connection with the recent announcement by Alfred Hickman, Limited, of their intention to extinguish a furnace, it is now stated that one of the furnaces in Northamptonshire connected with the allied firm of Lloyds Ironstone will be put out, the reason assigned being the high price of coke combined with unprofitable selling prices. This, it must be confessed, is a depressing commentary on the course of business.

Falling Steel Values.

Steel prices are again falling, and this week cheap finished steel bar prices are down 5s. to 7s. 6d. per ton, making small bars of ½in. and ⅝in. sizes for common purposes, such as nut and bolt making, &c., £8 15s. minimum, compared with a previous range of £9 to £9 5s. Very low quotations are heard of here and there, particularly in regard to semis, but whether or not they indicate the general trend of the market, they are not representative yet. Irregularity must be expected so long as there is such an enormous proportion of unemployed productive capacity. It is stated that bedstead angles have been sold down to £8 15s. per ton. Semis have been in rather better inquiry during the week, but prices of steel sheet bars are falling, and are now, it is claimed, as low as £6 15s. and upwards, and Bessemer billets £6 17s. 6d. to £7 upwards. Steel wire rods are selling at £10 to £10 10s. The steel works of Belgium are competing very keenly for orders, and in large numbers are offering rolling programmes to encourage British business. Prices, however, are nearer those of local makers than for a long time past, and offer practically no inducement to the British buyer. Belated deliveries are now being received of continental semis bought some months ago at prices very similar to those which are now current in the home trade. Constructional engineers, while they are busier, complain that in this district they still have to pay 10s. more for their steel than is demanded from their competitors in the North of England. The railways have been coming forward lately with orders for constructional work, chiefly in the way of small bridges. These should call for good tonnages of steel, and Staffordshire steel masters are hopeful of securing some of the business.

Position of Coventry's Industries

Optimism is more to the front in engineering circles in Coventry than has been the case for a long time past. Inquiries this week elicit the fact that there is, notwithstanding the present slackness of trade, an increasing disposition to regard the future more hopefully, and there seems little reason to doubt that, as far as the motor industry at any rate is concerned, given freedom from labour troubles, the next home season will be a successful one. Aeroplane construction continues active at one Coventry manufactory, while at another the production of wireless broadcasting receiving sets has become an accomplished fact, the weekly output already being satisfactory. With the increasing popularity of broadcasting, the company hopes to embark upon a scheme of mass production which would entail an increase in the number of employees. There is just enough movement in the machine tool trade to indicate a very slow advance. The trade, however, is still suffering disorganisation through the disposal of surplus stocks. General mechanical engineering is stated to be "not quite so quiet as it was a little while ago."

Birmingham Brass Trade Wages.

Brassworkers in Birmingham have this week accepted a new wages agreement. The masters' original proposal was for a reduction of 16s. per week on the war bonus, but after negotiation a reduction of 7s. 10d. a week was agreed upon. The new scale, which leaves the bonus at 17s. 7½d., operates from Monday last, and is to remain in force for six months. If the cost of living comes down to 51 points, the old sliding scale may be reimposed, and before the end of the six months the position will be reviewed again. The bonus of youths of eighteen to twenty-one years is reduced by 3s. 11d. per week, making it 9s. 4d. The rates per week for the various classes of workmen are now as follows:—Fine casters, £3 17s. 8d.; common casters, £3 11s. 8d.; moulders, £2 19s. 8d.; getters down, £2 12s. 8d.; dressers (E grade), £3 3s. 8d.; polishers (E grade), £3 5s. 8d.; dressers (D grade), £2 18s. 8d.; polishers (D grade), £3 0s. 8d.; dressers (C grade), £2 11s. 8d.; youths, eighteen years of age, £1 7s. 4d.; nineteen years, £1 12s. 4d.; twenty years, £1 17s. 4d.

The South Staffordshire Edge Tool Trade.

The edge tool industry in South Staffordshire on the export side is experiencing a rather quieter time just now, but the position is due probably to seasonal movements of trade. A certain number of inquiries are abroad, but these are modest in character. There is a distinctly hopeful feeling that the new year will bring with it a more steady improvement and a more consistent flow of business. There is very little movement in prices, costs having been reduced to the lowest level.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THERE is a rather more cheerful feeling this week in the iron and steel markets, and some people here are doing a little more business. It is, however, doubtful whether this is really the beginning of a real improvement in the general situation, and many people are sceptical about it. The general conditions of trade in Lancashire are such that it is difficult to believe in anything more than a very temporary increase of business in iron, steel and metals. Apart altogether from the textile machinists, there can be no doubt that general engineering in the Lancashire district is in a very poor way. Sellers of fuel will all say that the buying on the part of the engineering trade here is rather worse than the buying on the part of the cotton trade. The latter trade has a concerted and compulsory restriction of output, but the former trade has no need of compulsion to restrict its activities. For this reason cheerful reports about improvement in the iron and metal markets do not convey that conviction which one would like them to have.

Metals.

Some merchants in the copper and non-ferrous metal trades have been doing a little better lately, but so far as the prices of copper are concerned the general position is unchanged. The price of copper sheets is maintained at £96; but the other prices in the manufactured section of the trade have not been advanced to a corresponding extent. Some fluctuations take place in standard and electrolytic copper, the former being of a speculative origin, and the latter being merely a reflection of the American exchange rates; but the prices quoted for English refined copper remain constant, as indeed they have done for months. The position in America is rather obscure. On the one hand, there has been a considerable increase of buying by the consumers, as is evidenced by the return of copper sales for September, and this is attributed to the return of more normal conditions in the supply of coal; but, on the other hand, there seems to be an expectation of a coming increase in the output of copper, and it is not known yet whether this will balance or exceed the growth in consumption. There is a fair proportion of the American copper-producing power which cannot be employed profitably unless prices are much higher than they now are, and it is possible that the larger producers may argue that it is better to keep prices at a level which will not enable these copper properties to operate. In any case there is no probability that the market will run away in the present state of industry, and probably steadiness in the prices is more desirable than any advance. Dealers in scrap metals are still giving a fair price for old copper, up to £56 10s. to £57 per ton, and it is therefore to be assumed that the demand for this kind of scrap is good, although one would think that refined ingots at £67 would be a better purchase unless the scrap was remarkably good. Scrap gun-metal and yellow brass remain very much below their intrinsic value. In the tin market there has been some improvement, but the buying of tin seems mainly for prompt use, and apparently it is the American demand which is keeping the market up. It has to be remembered that tin prices have risen by nearly £10 per ton since the middle of August, and it may be questioned whether this is not enough, although some experts in the market are foretelling higher prices. The market for lead remains very strong, and with a tendency towards higher prices for a time. One notices that the demand is for prompt delivery, and as a result the "backwardation" on forward metal is increasing. As your readers know, it fell from about 27s. 6d. to 12s. 6d. per ton and is now back at 22s. 6d. Spelter is a very steady market at round about £33 per ton. There is no very large consumption here yet; but at the same time the supplies are small and do not show any disposition to increase.

Pig Iron.

The market in Manchester for foundry iron is steady and quiet. There does not seem now to be any expectation of an immediate change, and consumers of ordinary foundry are inclined to buy for rather longer periods. This means that they do not hope to gain any advantage by waiting, and that they may just as well save themselves the trouble of buying in very small quantities. It does not yet appear that consumers of pig iron have any belief in the permanency of the present prices for pig iron, and the general idea seems to be that the market has not yet reached the bottom. At present, however, the rise in blast-furnace coke will certainly check any tendency to decline, and may lead to some temporary advance. Sellers of Derbyshire No. 3 foundry iron still quote 90s. per ton delivered in Manchester for prompt and up to the end of the year. There has been a renewal of inquiry from America for foundry iron, and if this means also a renewal of the American buying there will be no chance of a reduction in the prices of Scotch and Cleveland iron. The latter does not concern Manchester, but the former is a matter of importance, and Manchester ironfounders are very much inconvenienced by the persistence of extravagant prices for Scotch foundry iron. There has been some increase in the price of East Coast hematite, said to be the result of American buying, and this class of iron is now quoted at 93s. per ton at the furnaces. It is, however, still a cheap material for Manchester if the founders can manage to use it instead of Scotch iron.

Finished Material.

There is practically nothing to be said about the market for manufactured iron and steel. Things are quiet here and prices keep on a dead and unremunerative level. Some people say that the inquiry is slightly better, but it is difficult to be sure of this fact.

Scrap.

Dealers are still complaining of the difficulty of disposing of sufficient quantities of scrap. The prices do not alter, but what is curious is that, in spite of the fact that foundry scrap and forge scrap are both very cheap materials, only a small quantity is being used. For cast scrap the prices range from 75s. to 82s. 6d. per ton according to quality, and for heavy wrought scrap the forges are offering only 65s. delivered.

Barton Power Station.

There was a very large attendance of members

of the Manchester Association of Engineers on Saturday last to inspect the new power station which is in course of construction by the Manchester Corporation at Barton. The members were conducted over the works by Mr. S. L. Pearce, the chief engineer and manager, and his staff. It was, of course, impossible for the visitors to study the whole of the details of such a large undertaking in the time at their disposal; but the main features, which have previously been referred to in this column, were open to inspection. The site embraces some 14¼ acres in close proximity to the Manchester Ship Canal and the Bridgewater Canal, the former of which will supply the condensing water, while the latter will enable coal to be delivered on to the site direct by means of barges. The red sandstone rock underlies the whole of the site at a depth of about 6ft. to 10ft. below the surface, so that the foundation work was comparatively simple. The buildings generally are of steel frame construction and the turbine-house is 243ft. long, with a width between the walls of 65ft. This, when fully equipped, will contain three 27,500-kilowatt turbo-alternators, one of which is already nearly complete. These machines are being supplied by Metropolitan-Vickers Electrical Company, Limited, and the condensing plant by Richardsons, Westgarth and Co., Limited. The turbines are designed to work with steam at 350 lb. pressure and 700 deg. Fah. The alternators will generate current at 6600 volts, which will be stepped up to 33,000 volts, at which pressure the current will be transmitted into the Manchester area of supply. The boiler-house is 314ft. long by 87ft. wide, with a total height of 87ft. This will contain nine Babcock and Wilcox water-tube boilers of the double-fired marine type, and each boiler is expected to evaporate 120,000 lb. of water per hour with fuel of a calorific value of 10,500 B.Th.U. These will be the largest boilers of the kind in the United Kingdom, and each boiler with its stokers, superheater, economiser, air heater, chimney, and induced and forced draught fans will be a complete unit in itself. Another special feature of the boiler-house is the ash department, which is on the ground floor, and will permit standard-gauge wagons or road vehicles to be filled directly from the ash discharge hoppers of the boilers, thus dispensing with suction ash plants and conveyors. In order to deal with canal-borne coal a dock and lay-by is in course of construction, from which coal can be unloaded by two overhead travelling cranes. The coal unloading plant has been supplied chiefly by W. J. Jenkins and Co., Limited, Retford. Coal can also be brought on to the site by rail, in which case the fuel is weighed in the trucks before unloading, while that received by canal is weighed by two automatic machines fed by grabs or boxes. Storage capacity for 25,000 tons of coal is also provided. This will be sufficient for seven weeks' consumption. The whole of the current transforming plant has been supplied by Metropolitan-Vickers Electrical Company, Limited. The main three-phase "step-up" transformers for each generator are two in number and of 19,500 kilo-volt-ampère capacity each. The auxiliary transformers are three in number of 1250 kilo-volt-ampères each and supply in part the station power requirements at 400 volts, stepped down from the 33,000-volt bus-bars. The generators are connected direct to their transformers and all switching is done on the 33,000-volt side without interposing any switchgear between the 6600 and 33,000-volt circuits. The switch-house is about 215ft. long by 52ft. 6in. wide and comprises three floors.

BARROW-IN-FURNESS, Thursday.

Hematite.

There continues to be every sign of development in the hematite pig iron trade, and there is evidence of trade improving at a greater rate than it has been doing. There is no doubt that as soon as the engineers get more to work—and there are signs of this from many quarters—great impetus will be given to the iron trade. This period of activity may not really develop until the beginning of next year, when the engineers' wages come down to minimum. This week will see a furnace put in blast at Carnforth. These works have been idle for nearly two years. Scotland is increasing its demands for delivery, and this trade, combined with the continental business, is growing every day. There is a much greater demand for special qualities of low-phosphorus iron by engineers. The stocks held by various smelters are being reduced, and what with increasing trade and the absence of stock, it looks as if more furnaces will be needed soon unless the steel trade enters on to a quieter period. At present the steel departments are taking a fair quantity of iron, especially at Barrow. Both ferro-manganese and spiegel are enjoying a better market.

Iron Ore.

The iron ore trade is improving slowly, and as the local demands increase so will the output at the various mines. The putting in of more furnaces will affect the trade, which is undoubtedly better. Stocks of foreign ore exist at the Barrow Docks, but they are gradually being reduced. There have not been very heavy imports lately, and they are not expected until stocks are down.

Steel

The steel trade does not offer at the moment the same signs of activity as does the iron industry, but in a few months better prospects are hoped for. It is thought that the new railway groups may prove good customers for rails, &c. The Barrow rail, merchant and hoop mills are employed still, but the orders held at present by the United Steel Company's works at Workington will not keep them engaged longer than two weeks or so.

SHEFFIELD.

(From our own Correspondent.)

Progress of the Heavy Trades.

THE improved feeling in the steel trade continues. The improvement so far is of a partial character, and relates only to a few branches, so that little impression has yet been made on Sheffield's huge total of about 40,000 unemployed, but the progress is in the right direction, and affords ground for hope of further advance. It is chiefly in basic steel that the expansion is noticeable. There is a brisk home demand for this material, and, with German competition practically out of the way, our British manufacturers are reaping the benefit of the trade. Unfortunately, there are not many Sheffield firms concerned in this business. At Parkgate and Ickles, however, almost full employment is being enjoyed. The United Steel Companies, Limited, has six of its large furnaces at Templeborough at work, producing about 4000 tons of ingots per week. Some of this output, however, has to be stocked, as the volume of trade does not yet afford an outlet for the whole of it. A large tonnage of finished material is also being turned out by the United Strip and Bar Mills Company, at Ickles, near Rotherham.

Poor Trade in Crucible Steel.

In contrast with the improving conditions in heavy steel is the still very depressed state of trade in fine steels. There is a little better demand for ordinary crucible steel, but for those expensive alloy materials which are used for making the best tools, there is little inquiry, comparatively speaking. The condition of this important branch of the local trade has been very bad for the past two years, and it shows little sign of mending. Of course, the home market takes a large quantity of tool steel, and the improving condition of engineering is promising, but, on the other hand, the export trade, on which this department is largely dependent, is practically cut off by the prevailing international financial situation. The continental countries, with their depreciated exchanges, are now unable to buy Sheffield material, and there are those in the trade who see no hope of a return to anything like normal prosperity until comparative values of money are considerably altered. At present European users of tool steel are having to do the best they can with native supplies. There is little doubt that, should conditions become more favourable, they would willingly buy Sheffield goods again, for Sheffield's supremacy in special steels is still acknowledged the world over.

The Lighter Industries

The satisfactory improvement in the electro-plate trade is well maintained. There is a continuous flow of orders for the Christmas trade, and many of the firms are quite fully employed, and look like being so right up to the year end. There are exceptions, and some of the factories could do with more work, while competition is so severe that prices and profits have alike come down, and some of the work being done can hardly be called remunerative. The improvement in the demand comes chiefly from the home market. It is of a wide-spread character, for, while it relates chiefly to goods of inexpensive range, there is also a fair request for the best qualities. The spoon and fork branches continue exceptionally busy. The Colonies are not placing orders on the same scale as a year ago, and this side of the trade is disappointing. There is a considerable improvement in the cutlery trade, although its condition does not equal that of electro-plate. Stainless table knives continue to be the leading line, and there is not much being done in the pen and pocket knife branches. A good trade is being done with Australia, and there is not much fear now of Sheffield being handicapped by the opening of the Commonwealth ports to German shipments.

Business and Religion.

Sheffield was the scene of the Church Congress last week, and one of the most interesting papers, to business men, was that contributed by Mr. W. L. Hichens, chairman of the great firm of Cammell Laird and Co., Limited. Mr. Hichens is well known for his liberal opinions on questions of capital and labour, and social problems generally, and his address on "The Gospel in Business" was looked forward to with much interest. Religion and business, he said, could no longer be kept in separate water-tight compartments, and the Christian business man could not allow himself to be guided merely by the rigid doctrines of political economy. From the Christian standpoint, the idea of rendering service to God and to our fellow-men must rank above all other considerations. While religion had nothing to do with economic laws as such, it had a great deal to do with the application of those laws. Having gone thus far, however, Mr. Hichens quite definitely opposed any idea of the Church interfering in the actual details of industrial problems, such as taking sides in wage disputes. He pointed out that no industry could for more than a short time pay wages which involved it in a loss. It might temporarily finance such losses out of its reserves or by means of loans. But as soon as its credit was exhausted it must either close down and pay no wages at all or it must pay the wages which it could afford. He did not wish to express an opinion as to whether the present industrial depression was sufficient to justify a reduction of wages below the standard of 1914. His point was that those who condemned such a reduction as morally wrong without a full knowledge of all the facts were likely to do more harm than good, and he did not think that the Church organisations had the full information on which to base a sound opinion. The wish that wages should be high was not sufficient justification for the thought that they ought to be and could be high. He believed that the cure for our industrial troubles was only to be found in the application of Christian principles to our industrial lives, and he desired that the teaching of the Church should have full authority. He thought, however, that that authority would be disastrously weakened if it attempted to give decisions on industrial problems with which it could not be familiar.

Tramcar v. Motor Omnibus.

Sheffield is looking forward to several extensions of its tramway system, basing its hopes on the more moderate prices that are now ruling. While making full use of motor omnibuses as feeders, the city is still firmly wedded to its tramway system, and a paragraph which appeared in this letter of September 1st was capable of creating a wrong impression on this matter. Mr. A. R. Fearnley, the general manager of the Corporation tramways, informs me that the curtailment of the programme of extensions was not at all on account of omnibus competition. It was solely due to the high cost of rails, material and labour, and as those costs are coming down, the extensions are gradually being put in hand. One short extension has been sanctioned by the Tramways Committee during the past fortnight. "There can be no suggestion in Sheffield," Mr. Fearnley adds, "of the tramcar being superseded by the motor omnibus. The latter vehicle has not the carrying capacity. Until great strides are made in motor omnibus design and construction, it has not a chance of getting on even terms with the tramcar for city and suburban work."

Coal Cutting by Machinery.

An interesting development in the use of coal-cutting machinery is to be made at the new Clipstone Colliery of the Bolsover Colliery Company, on the Notts. and Derbyshire borders. Mr. S. Evans, agent of the Bolsover Colliery Company, states that they are hoping to be able to work the machines in the top hard seam, which will be a new departure so far as that seam is concerned. The machines will be worked by compressed air.

Municipal Schemes.

Sheffield Corporation has this week started work on a new arterial road from its Norwood estate to Wardsend. The undertaking will cost about £80,000, and will find employment for six months for 3000 men, 1500 working alternate weeks. It is expected that when this work is completed, another road scheme at Richmond-road, which will employ a similar number of men, will be started. Of six new schemes which the Corporation recently submitted to the Unemployment Grants Committee, four have now been sanctioned, and the other two are still under consideration. Those approved include the tramway extension from Woodseats to Abbey-lane, the extension of the Coisley Hill sewage works, and other sewerage and paving works in various parts of the city. The total estimated cost of the four schemes is about £38,000, and employment will be found for 300 men. The Wortley Rural District Council has received sanction to proceed with nine road-making and sewerage schemes in its area. The total cost is estimated at about £30,000, and employment will be found for 400 or 500 men for twelve months.

Hull Tram Rails.

The contract for 1000 tons of tram rails for the Hull Corporation, to which I referred last week, is not yet settled. At the meeting of the Hull City Council it was stated that, in addition to the three tenders previously mentioned, there were three others, namely, those of Frank Mott and Co., Limited, London, manufactured in Germany, £9 8s. 6d. per ton; Cargo Fleet Iron Company, Limited, Middlesbrough, £12; Walter Scott, Limited, Leeds, £12 10s. The offer of Steel, Peech and Tozer, Limited, of Sheffield, was £11 15s. per ton, and the Tramways Committee recommend that the company be asked to make a reduction in order that the work might be kept in this country The Committee's suggestion was fully discussed by the Council, and various opinions, favourable and otherwise, were expressed. Eventually, the chairman decided to take the matter back for further consideration.

NORTH OF ENGLAND.

(From our own Correspondent.)

Brighter Trade Outlook.

WHILE it is well to be guarded when taking stock of the trade outlook, the present indications certainly point to better times in North of England industry in the near future. The latest official statistics denote increased production in the iron and steel trades, and a more progressive improvement is foreshadowed as the result of orders which have been placed recently. Three steel furnaces have been re-started this week at the Port Clarence Works of Dorman, Long and Co., Limited. The steel plant at these works, which had been in operation regularly for some time, was closed down in August, owing to the depression in trade. Orders now having been received in the other mills of Dorman, Long and Co. for steel ingots, some work has been found for the Clarence Works. The decision of the Newport (Mon.) Corporation regarding the contract for the new water scheme is awaited with considerable interest on Tees-side. It is understood that the two local foundries have withdrawn their tenders for the supply of iron pipes, and the Corporation Works Committee recommends the Town Council to award the entire contract to Cochrane and Co., Limited, of Middlesbrough, whose price is £101,960.

Cleveland Iron Trade.

The enormous American demand continues to be the outstanding feature of the Cleveland pig iron trade. The huge shipments which have already been made have quite failed to satisfy the American requirements, and although a good deal more iron has been sold for early shipments, there are still a large number of inquiries circulating. It appears that costs of production are still very high in the United States, and transport facilities are most unsatisfactory, with the result that even with freight charges and import duty added, Cleveland iron is much cheaper than the American product. The effect of this demand, coupled with the high price of coke, is to keep prices very firm, and so long as fuel prices remain at their present level—and there is no sign of any weakening—ironmasters cannot afford to cut prices. On the other hand, the high prices now being quoted have the effect of shutting out Cleveland iron from many other markets. It is too dear for Lancashire consumers, and except in the immediate vicinity, even Yorkshire engineers and founders find it cheaper to use Midland iron, whilst continental buyers are also inclined to look elsewhere. No. 1 and siliceous iron is 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; and No. 4 forge, 85s.

Hematite Pig Iron.

A marked improvement is reported in the East Coast hematite pig iron trade. Makers' stocks have gone, and they are now well sold for deliveries over the rest of the year. The home demand is brisker, small Belgian and Italian orders have been placed, but again the strongest demand is from America. Mixed numbers of hematite are quoted at 92s. 6d., both for home use and export.

Iron-making Materials.

The foreign ore trade remains very dull. The long abstention of buyers has weakened the position so that the price of best Rubio ore has fallen to 23s. per ton c.i.f. Indeed, it is reported that that figure has been cut without attracting business. Some of the coke makers quote 31s. per ton as their minimum for blast-furnace coke delivered at the works, and even then declare they are selling at a sacrifice, as they can get 32s. 6d. for export. Some of the coke makers, however, are not prepared to squeeze old customers, and are selling as low as 29s. 6d. per ton.

Manufactured Iron and Steel.

The trend in the manufactured iron and steel trade is towards greater activity. A few orders for shipbuilding material are now being placed, and rail orders are not so scarce, whilst general engineering and constructional requirements tend to increase. Prices do not show any variation, except that common iron bars are 10s. cheaper, the price now being £10 10s.

The Coal Trade.

The Northern coal trade retains all its strong features, and the outlook is full of promise. The position of practically all the collieries in both counties is very satisfactory; the entire output is almost entirely disposed of for the next few weeks, leaving only odd lots available for market transactions from time to time, which are placed at outside prices. In second hands the quantities are strictly limited, and just now concessions are not easy to negotiate. Most of the sellers adhere rigidly to top quotations. The question of shipping turns is now most acute, and congestion at the staiths and docks is once more prevalent. Numbers of vessels have to undergo considerable detention, thereby incurring heavy demurrage charges. The export trade is exceedingly brisk, and as a rule the shipments are heavy, but most of the coal shipped is against contracts, with German business very much in evidence, though the pressure from that quarter is not so great as it was a while ago. There has been a fair amount of contracting ahead recently, and a strong position seems assured for some time to come. Best and second Northumberland steams of every brand are rigidly firm, with every class of small steams steady, and now becoming rather sparingly offered. Durham gas coals are keenly in request. Both prime sorts and seconds find a quick and profitable sale when supplies are available. Coking coals are scarcer than ever, while bunkers are also firm. Coke is a firmer market, both for all classes of foundries and gas coke.

SCOTLAND.

(From our own Correspondent.)

Clouded Prospects.

For a few weeks conditions seemed to be advancing towards industrial improvement, and hopes were entertained that the autumn months would witness an acceleration of the movement. Once again, however, hopes seem doomed to disappointment so far as the year 1922 is concerned, at any rate. Markets still exist in a state of uncertainty, aggravated by the political situation at home and abroad, and contingencies attached to the former at least are sufficient to continue the period of uncertainty. Little hope is now expressed that any material improvement can be looked for, this side of the New Year. Occasional bursts of activity may be met with, but nothing approaching a general movement is at all likely.

Lead Mines Reopened.

The lead mines at Tyndrum, Argyllshire, have now been reopened. Operations have been commenced on a new level, and a compressor has been installed. It is said that operations will provide work for local unemployed.

More Shipbuilding Orders.

Shipbuilding orders are being added to slowly, but, nevertheless, it is gratifying that they come at all in times like the present. It is just reported that an order has been given for a Holt liner of 7500 tons to be built at Greenock. Another vessel of considerable proportions has been tendered for, and a few orders for smaller craft are in prospect.

Pig Iron Firm.

The Scotch pig iron market is firm in tone. Makers are finding a ready outlet for their production, chiefly in an export direction. The home demand is small, and almost entirely of a hand-to-mouth description.

Steel and Iron.

The steel works continue to run slowly, only a small proportion of the plants being in regular employment. One or two establishments may have benefited to some extent by the recent shipbuilding orders, but the majority have great difficulty in keeping a minimum amount of the plants in operation. Day-to-day specifications are the rule in practically all branches of the trade. Steel plates are poorly bought, and sectional material has quietened down. Sheet makers have for some time been feeling a lack of orders for the heavier gauges, and now the business in the lighter varieties has tapered away to a considerable degree. Bar iron is no better off. An occasional good specification on home or export account comes along, but for the most part the works are living a hand-to-mouth existence. Quotations all round are apparently maintained, but a favourable order for almost any class of material could secure better terms.

Coal

A firm tone has been maintained in the Scotch coal trade throughout the past week. Export demands have been steady, and the collieries in all districts are comparatively well placed at present. Practically all descriptions of round fuel are in demand, and prices are a shade firmer. Inquiries from Canada have been in circulation and a few firm orders are already reported. Washed materials are heavily booked, especially in Fifeshire and the Lothians. Business on home account is quiet, all demands being easily satisfied. Shipments have been somewhat restricted, owing to stemming difficulties, but the figures are comparatively good, reaching 337,657 tons, against 355,659 tons in the preceding week, and 330,692 tons in the same week in 1913.

Antagonism to Miners' Union.

The "rebellious" element in Fifeshire is growing in strength. Another branch has just been added to the number withholding their contributions from headquarters. Mr. Adamson, the general secretary of the union, was in the district within the past few days, but up to the present his efforts have been of little avail.

Lanarkshire Working Week.

It is said on good authority that proposals, based on a general recognition of the necessity for altering the working policy throughout the Lanarkshire coalfield, will immediately be laid before a special conference of the delegates of the Lanarkshire Miners' Union. The delegates are to consider if the time is not now opportune for endorsing a working programme of eleven days per fortnight, which is the arrangement in operation in other parts of Scotland.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

Although in a way conditions prevailing in the steam coal export trade are quieter, nevertheless the tone is very good, and collieries are very well placed for the remainder of this month and the early part of next. This applies more particularly to the superior coals, as the demand for the lower grades has been rather restricted, and home industries which consume in normal circumstances a very considerable quantity of the inferior qualities are not taking anything like the amount they should do. From the point of view of the foreign export trade, although the quantity of coal now being shipped to Canada and America is substantially less than was the case a month ago, it is satisfactory to note that the demand from the usual markets has improved to such an extent as practically to make up for the falling off in the Transatlantic demand. Continental consumers naturally held off when prices soared upwards as the result of the American and Canadian invasion, but they have been compelled to come in owing to the depletion of their stocks. Exports from this district for the month of September were exceptionally good, and exceeded 2½ million tons, which is equal to over 30 million tons per annum, this figure being only slightly below the pre-war record. Hopes are entertained that the exports for the current month will be at least equal to those for September, and if this turns out to be the case it will be very satisfactory if only from the point of view of employment in the coalfield and the effect upon the wages of the workmen. From all accounts there is the possibility that the official joint audit for September will enable the owners for the first time to retain the whole of their standard profits and pay a wage that may be in excess of the minimum which has been operating since last November. Unfortunately, clouds overhang this district in the shape of labour troubles, and from the declarations of the President of the South Wales Miners' Federation there is every indication that the notices will be presented to the colliery owners on the 23rd inst. on the non-unionist question, which, of course, may mean that business will be interfered with, even if a strike does not eventually take place. The fact is that so far the efforts of the miners' leaders to get non-members into the Federation have not met with the success that they desire.

Ebbw Vale Dispute.

The collieries and works owned by the Ebbw Vale Company are still at a standstill, but efforts are being made to bring about a settlement. Towards the end of last week there was a conference between the representatives of the company and the workmen, but it was abortive. A deputation from the workmen's side thereupon visited London, and had an interview with the Mines Department in order to place before it the seriousness of the position. The Mines Department was assured that unless a settlement was effected in the immediate future the matter would cease to be one in which the Ebbw Vale workmen alone were interested, and it would become a question of vital importance to the whole of the men in the coalfield. Since then Mr. W. L. Cook, of the Ministry of Mines, has paid a visit to South Wales in order again to examine the situation and endeavour to bring the parties together, and at the moment of writing it is practically arranged that a further conference shall take place. The attitude of the executive of the Federation is that it awaits the Ebbw Vale management carrying out the terms of the agreement entered into with the workmen on September 28th. This agreement provided that, subject to the workmen undertaking to accept Dr. Galloway's interpretation of the award and to no stoppage of work taking place without proper notice, activity would be resumed at the collieries. These conditions, the executive says, have been complied with since October 3rd.

Disputed Award.

Last week representatives of the South Wales Coal Conciliation Board had an interview with Lord Buxton, the independent chairman, respecting the interpretation he placed upon his recent award in regard to the subsistence wage for the lower-paid workmen. Lord Buxton gave his views, since which time he has committed his interpretation of the clauses in question to writing. His Lordship has decided that workmen between eighteen and twenty-one shall have their pay made up to 6s. 3d. and 6s. in classes A and B, with a maximum allowance of 6d. and 3d. respectively. In the case of men engaged on the afternoon and night shifts who receive a bonus turn for working five shifts, the independent chairman has laid it down that their total wage is to be divided by six and not five as contended by the coalowners, so that these men will be entitled to an allowance. In the case of men working on the continuous shift system and who are paid nine shifts for working, say, seven shifts, the ruling is that their earnings are to be divided by the actual number of shifts worked.

Blaenavon Steel Works.

The furnaces at the Blaenavon steel works have been damped down for an indefinite period. There were previously over 1000 steel workers idle, and their number is now augmented to the extent of several hundred more as the result of the company's action.

Current Business.

On the whole the market shows very little change from a week ago. New business is not coming along quite so freely, but the bulk of the collieries producing the better qualities of steam coal are very well stemmed for the remainder of this month and the early part of next, and prices are consequently very steady on the basis of 27s. to 28s. for the best descriptions. Inferior grades are irregular, while smalls are none too firm as the demand for them is quiet, and in order to push sales many collieries will not now sell large coals unless buyers take a proportion of smalls. Anthracite coals maintain a very good tone on the basis of recent prices, though duff coals are, if anything, better.

Tin-plate Prices.

A joint meeting of the Welsh Plate and Sheet Manufacturers' Association and the Siemens' Steel Association has been held for the purpose of arriving at an arrangement for better co-operation between the two wings of the trade, and an amicable decision was arrived at by which tin-plate manufacturers agree to a minimum price for tin-plates in consideration of a special rebate off the price of steel bars. It is understood that in consideration of the tin-plate trade establishing a minimum price of 19s. 3d. per basis box the Steel Association agrees to a rebate of 7s. 6d. in the price of bars, viz., from £7 7s. 6d. to £7.

Non-unionist Notices.

The Executive Council of the South Wales Miners' Federation, at a meeting on Wednesday, decided unanimously to tender a fortnight's notices on Monday next, but workmen necessary for the safety and maintenance of the collieries are to continue at work.

Later.

Ebbw Vale Dispute.

As the result of the intervention of Mr. W. L. Cook, of the Ministry of Mines, representatives of the Ebbw Vale Company, and officials of the Federation, met in conference on Wednesday, but the parties again failed to come to an agreement. It was officially stated that subject to there being no general stoppage of work in the whole coalfield on the non-unionist question, the company offered to reopen the pits so far as trade would permit on the terms on which the men were working prior to the stoppage, and to grant an extension of such terms for one month to enable both sides to discuss the question of allowances. The men's representatives, however, decided to refer the matter to Mr. Evan Williams, the chairman of the South Wales Conciliation Board, who has suggested that, in view of the deadlock, some useful purpose might be served by a discussion of the matter unofficially between a few members on the coalowners' side and a few of the workmen's leaders. It is probable that a conference on these lines will be held on Saturday.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Council of the Institution of Mining and Metallurgy has awarded the gold medal of the Institution to Sir Alfred Keogh, G.C.B., G.C.V.O., C.H., Hon. M. Inst. M.M., "on the occasion of his retirement from the Rectorship of the Imperial College of Science and Technology, in recognition of his great services in the advancement of technological education and as a mark of admiration and respect."

The Council of the Institution of Mining Engineers has awarded the medal of the Institution to Sir George Beilby, LL.D., F.R.S., "in recognition of his valuable contributions to science, with special reference to his researches on fuel."

We are asked to announce that early in December next Mr. Conrad F. Mendham, M.I. Mech. E., M. Cons. E., consulting engineer, of 77, Belgrave-road, S.W. 1, is closing down his practice in London, and proceeding to Hong Kong, where he will join the firm of W. S. Bailey and Co., Limited, engineers and shipbuilders, as their assistant managing director.

Hobdell, Way and Co., Limited, ask us to announce that they have moved their offices from St. John's House, 124 to 127, Minories, London, E. 1, to 45, Church-street, Minories, E. 1. Their new warehouse address is Haydon-square, Minories, E. 1. The telephone numbers remain the same as hitherto, namely Avenue 3810 (three lines).

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 12 6	4 12 6
No. 1	4 13 0	4 13 0
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 10 0	4 10 0
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands—		
3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 1 6 to 4 2 6	
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 6 6	—
Foundry	4 6 6	—
Forge	4 6 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. Coast—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	10 10 0 to 11 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 15 0 to 9 17 6	
Gas Tube Strip	11 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates ¾in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ½in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 5 0	—
Soft Billets	7 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Manchester—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 5 0	—
Soft ,,	7 5 0	—
Hoops	11 15 0	—
Soft Wire Rods	10 0 0	—
Midlands—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 5 0 to 16 10 0	
Angles	8 15 0 to 9 0 0	
Joists	9 0 0 to 9 10 0	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/- to 19/3
Block Tin (cash)	169 7 6
,, (three months)	170 10 0
Copper (cash)	62 10 0
,, (three months)	63 2 6
Spanish Lead (cash)	25 7 6
,, (three months)	24 7 6
Spelter (cash)	34 2 6
,, (three months)	33 2 6
Manchester—	
Copper, Best Selected Ingots	67 10 0
,, Electrolytic	72 0 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	26 15 0
,, Foreign	25 12 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£30	12/-
,, 6 p.c. to 8 p.c. ,,	£22 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£21 10 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£53 0 0	26/-
,, ,, 1 p.c. ,,	£78 0 0	30/-
,, ,, 0·75 p.c. carbon	£75 0 0	37/-
,, carbon free	1/7 per lb.	
Metallic Chromium	5/- per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale unit	5/- per
,, ,, 75 p.c.	20 10 0 scale unit	6/- per
,, Vanadium	17/- per lb.	
,, Molybdenum	8/- per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	23/-
,, ,, Ell	24/-
,, ,, Splint	24/- to 26/-
,, ,, Trebles	23/6
,, ,, Doubles	22/-
,, ,, Singles	19/6
Ayrshire—	
(f.o.b. Ports)—Steam	23/-
,, ,, Splint	24/-
,, ,, Trebles	23/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	21,6 to 25/-
Screened Navigation	23/-
Trebles	23/9
Doubles	22/6
Singles	20/6
Lothians—	
(f.o.b. Leith)—Best Steam	23/6
Secondary Steam	23/-
Trebles	21/6
Doubles	22/3
Singles	21/3

ENGLAND.

(8) N.W. Coast—	
Steams	29/6
Household	46/8 to 57/6
Coke	34/-
Northumberland—	
Best Steams	26/- to 27/-
Second Steams	24/- to 24/6
Steam Smalls	15/- to 16/6
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 24/6
Second	22/- to 22/6
Household	25/- to 28/-
Foundry Coke	37/- to 40/-
Sheffield— Inland.	
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 25/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	18/6 to 20/6 —
,, ,, Small ,,	15/- to 16,6 —
York-hire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	8 6 to 10/6 —
Nutty ,,	7/6 to 8/6 —
Smalls	3/- to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-

(9) SOUTH WALES.

Cardiff— Steam Coals:	
Best Smokeless Large	27,6 to 28/-
Second ,, ,,	26/- to 27/-
Best Dry Large	28/- to 28,6
Ordinary Dry Large	27,6 to 28/-
Best Black Vein Large	25/ to 26/-
Western Valley ,,	24,6 to 25,6
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	22,6 to 24/-
Best Steam Smalls	16/- to 16/6
Ordinary ,,	12/ to 14/-
Washed Nuts	25/ to 30/-
No. 3 Rhondda Large	28/- to 29/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/6 to 19/6
,, ,, Smalls	12/- to 14/-
Coke (export)	35/- to 40/-
Patent Fuel	26/- to 28/-
Pitwood (ex ship)	29/6 to 30/6
Swansea— Anthracite Coals:	
Best Big Vein Large	55/- to 57/6
Seconds	45/- to 47/6
Red Vein	40/- to 45/-
Machine-made Cobbles	65/ to 70/-
Nuts	70/- to 72/6
Beans	45/- to 47/6
Peas	22/- to 23/-
Breaker Duff	8/- to 9/-
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	21/6 to 22/-
Seconds	23/- to 24/-
Smalls	12/- to 14/-
Cargo Through	19/6 to 22/6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanark-hire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Colonial Development.

The past week has witnessed several manifestations of the interest being taken in the development of the colonial resources in raw material. Apart from the advantage of a country being able to produce all the material it needs, there is the necessity of making arrangements to procure at home what, in the more or less distant future, it will be almost impossible to obtain abroad. This is especially the case with liquid fuels which have been thoroughly dealt with at the Congress held in Paris, when the production of alcohol at home and of vegetable oils in the colonies occupied a very large part of the deliberations. At the same time, there was a Congress on Colonial Organisation at Marseilles, when the various methods of encouraging and aiding colonial enterprise were discussed. The idea is to organise and equip the colonies in such a way that they will offer a lucrative field for companies which have the means of carrying out operations on a large scale. It was with this object in view that the Minister of Colonies prepared his programme of public works which will be brought before Parliament at the beginning of next year, when it is hoped that the necessary funds will be voted to allow of the work being undertaken without further delay. Meanwhile, the Government of Madagascar is inviting tenders from French firms for the carrying out of harbour improvements and extensions and railway works in that island. New companies are continually being formed to engage in colonial undertakings, chiefly for the industrial utilisation of agricultural produce, and one of them aims at exploiting a process for manufacturing paper pulp from reeds, the leaves being employed as fuel in a suction gas producer supplying the motive power for the factory. Samples I have seen of paper made from the pulp appear very promising. The problem of producing paper pulp from colonial produce is only less in importance to that of creating a vast cotton industry with the aid of irrigation.

New Markets.

The colonies can never become important markets for manufactured goods, except for machinery and plant required to develop their natural resources. Much of this machinery is of a special character that French makers are not yet in a position to supply, and for a long while to come the needs will have to be met largely by foreign manufacturers who specialise in machinery for colonial use. While, therefore, with the aid of mechanical plants, the thinly populated territories will in time be exporting enormous quantities of raw material, they will take comparatively little in return, and French manufacturers are consequently obliged to depend upon foreign markets for the disposal of their goods. In addition to the colonial activity, there is a growing movement in favour of improving business relations with other countries, and it has been still more pronounced since the operation of the Fordney Tariff Bill practically shut French manufactured goods out of the United States market. The time has arrived when something should be done to take advantage of this movement in the direction of facilitating international trade. Efforts have been made by means of commercial agreements to promote business with the countries of the *Petite Entente*, but the only result so far has been the investment of French capital in industrial enterprises, as those countries are hardly yet in a position to purchase considerable quantities of French goods. With Russia, too, there is hope that something will be done in the early future. While the Government has refused to countenance official relations with the Soviets, the industrial community of Lyons is looking hopefully to Russia, and messages that have passed between Lyons and Moscow seem to point to a change in the attitude of the French industrial classes. Another significant factor is the departure last week of the battle-cruisers Jules Michelet and Victor Hugo on their nine months' commercial cruise. The vessels are fitted up with show-rooms, containing samples of French goods and everything necessary, in charge of experts, to impress upon the inhabitants of the places visited the importance of French resources, and as the programme includes parts of the British Empire, it may be hoped that the cruise will prove the beginning of closer business relations with Great Britain.

Franco-British Trade.

How far the business relations between France and Great Britain have been improving, despite the disabilities of the exchange rate, is observable in the detailed returns for the first eight months of the year, which, however, only give the values of the goods imported and exported, and cannot therefore be taken as accurately reflecting the situation. Nevertheless, the fact of values having declined during the year implies that there must have been an improvement in quantity. Compared with the first eight months of 1921, the value of goods imported from Great Britain rose from 193 million francs to 256 million francs, while the exports from France to Great Britain declined from 319 million francs to 242 million francs. The purchases from the United States were valued at 266 million francs, as compared with 225 million francs. The values of goods sent to Belgium and Germany were much higher, but the imports from those countries declined considerably.

Aviation.

Including the credits which the Chamber of Deputies is being asked to vote for 1923, the Aviation Department will have at its disposal a sum of 150 million francs, of which about one-third will be devoted to the subsidising of air lines. Provision is made for the purchase of new types of aeroplanes and helicopters and aeroplanes of very large capacity, as well as for the creation of a magnesium industry for the manufacture of light alloys. Only a comparatively small sum is set apart for purely experimental and research work, and it is argued that more money could be profitably devoted to this object than to the creation of new air lines.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

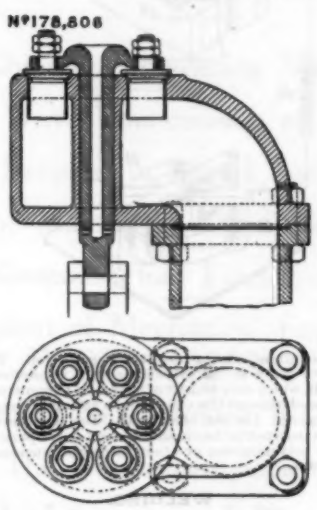
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM ENGINES.

178,806. March 3rd, 1922.—Regulators, J. Lejeune, 18, Avenue Prekelindey, Woluwe, St. Lambert, Belgium.

This regulator, which is primarily intended for locomotive service, has a plurality of valves arranged round a central stem. The stem is provided, at its upper end, with a series of arms which

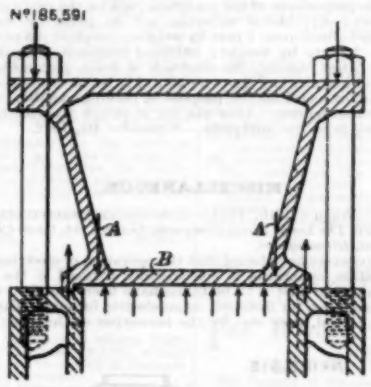


engage the stalks of the several valves. A certain amount of lost motion is allowed in the connection between some of the arms and their valves, in order that all the valves will not be opened simultaneously. It is claimed that one of the advantages of the regulator is that it reduces the swirling of the steam as it passes through the valves.—*September 14th*, 1922.

INTERNAL COMBUSTION ENGINES.

185,591. July 26th, 1921.—Cylinder Covers, R. Hildebrand, Greeley-avenue, Webster Groves, St. Louis, Missouri.

The design of this cylinder cover is intended to provide against the upward deflection of the cover by the internal pressure of the explosion and to reduce the stresses internal to the cover caused by temperature differences. With these objects in view the form

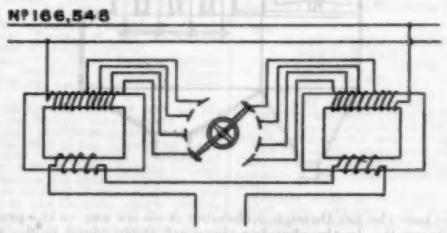


shown is chosen so that the downward pressure at A A, produced by the cover bolts, tends to bend the plate B downwards, or contrary to the tendency of the gas pressure. At the same time the outer edge of the plate, which is not subject to so great a heating effect as is the centre, is not cooled by the water jacket.—*September 14th*, 1922.

TRANSFORMERS AND CONVERTERS.

166,548. July 15th, 1921.—Improvements in or relating to Static Transformers for Alternating Currents, Société d'Electro-chimie et d'Electro-metallurgie, of 2, Rue Blanche, Paris.

The object of this invention is to avoid destructive arcs and

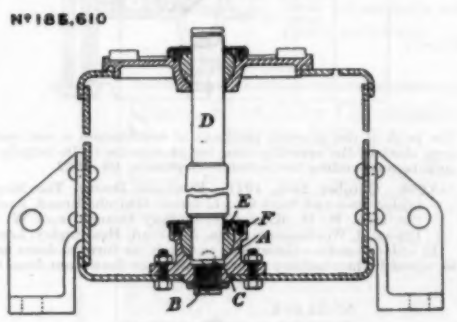


sudden disturbances when changing the tappings of transformers by means of switches. Transformers constructed in accordance with the invention are composed of two magnetic circuits each carrying a primary and a secondary winding. The primaries are connected in series and are connected on to the feeding network. The secondaries are also in series and feed the distribution network. The multiple contact changes are made either on the two primaries or on the two secondaries or simultaneously on the primaries and secondaries by means of a special switch which is designed so that on each transformer the contact brush does not leave a contact piece before reaching the following one, and the change from one contact piece to another does not take place simultaneously on the two transformers, but successively and alternately on one and the other.—*September 14th*, 1922.

SWITCHGEAR.

185,610. August 12th, 1921.—Improvements in Electric Controllers, Montagu James Patterson and the Electro-Mechanical Brake Company, both of Eagle Works, West Bromwich, Staffordshire.

According to this invention the bearings of controllers are made self-aligning by forming the journal sleeves in which the shaft engages so that they can rock slightly in the brackets which support them. In the construction illustrated the bearing at the base of the controller comprises a substantially cylindrical flanged casting A, bolted to the base and carrying at its centre a hardened steel plug B, which takes the weight of the controller drum through a ball C interposed between it and the end of the

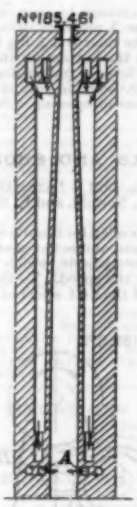


spindle D. To permit of adjustment in height of the drum to suit slight variations in the casing, the plug is made to screw into the casting. The inner surface of the cylindrical part of the casting A is shaped to form a spherical zone within which fits a journal sleeve E of corresponding spherical outer surface, and fitting the end of the controller spindle which rotates within it. A flanged retaining ring F screwed upon the top of the casting engages with a recessed part of the journal sleeve E. A substantially similar construction is adopted for the upper bearing.—*September 14th*, 1922.

GAS PRODUCERS.

185,461. May 3rd, 1921.—Vertical Retorts, Woodall, Duckham and Jones (1920), Limited, and Sir A. McDougall Duckham, 52, Grosvenor-gardens, London, S.W. 1.

In this specification it is stated that in the operation of carbonising fuel in externally heated vertical retorts steam is frequently introduced into the bottom of the retort for the purpose of reacting with the hot coke to form water gas. The proportion of steam permissible depends on the temperature of the coke, which temperature has been reached by the carbonisation of the mass of coal in the retort, and it has not been found profitable to extend the external heating of the retort to the part containing the coke so as to maintain the temperature of the latter to such a degree that an increased amount of water gas can be made. By this invention the temperature of the



coke at the lower part of an externally heated vertical retort is maintained for the purpose in question by introducing oxygen together with the steam, or alternately with the steam. The oxygen may be diluted with a certain proportion of nitrogen, say 40 per cent. of its volume, but the quantity of nitrogen thus introduced must not exceed that which, when mixed with the gas produced by the carbonising process as a whole, would bring the percentage of nitrogen to the maximum permissible with respect to the calorific value of the gas. By adopting this mode of internally heating the coke in the lower part of the retort, not only is the temperature better maintained, so that the output of water gas, and hence of total gas, is increased, but the cost of externally heating the lower part of the retort is saved. The oxygen is preferably admitted together with the steam at the openings A A at the bottom of the retort.—*September 4th*, 1922.

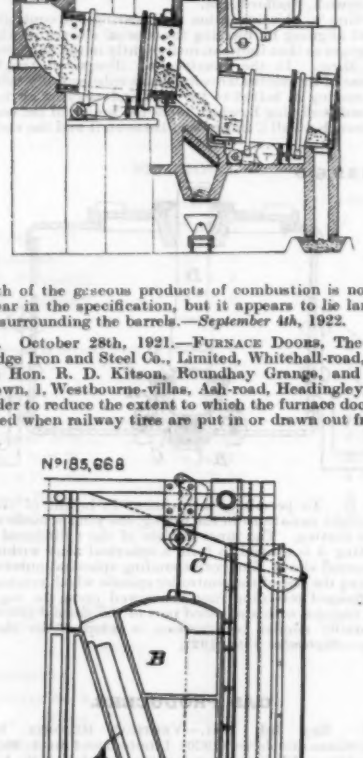
FURNACES.

185,492. June 2nd, 1921.—Refuse Destructors, J. S. Atkinson and Stein and Atkinson, Limited, 47, Victoria-street, Westminster.

In this destructor the material is passed successively, and apparently intermittently, through three rotating barrels. The

upper barrel serves for drying the refuse, which is burnt in the second one, while the clinker is collected in the lowest barrel. Between the two last-mentioned there is a combustion chamber.

No 185,492

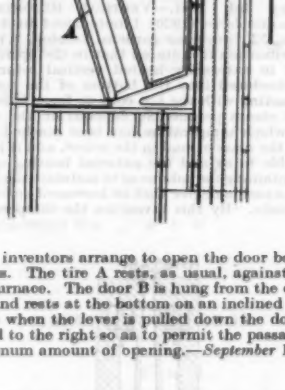


The path of the gaseous products of combustion is not made very clear in the specification, but it appears to lie largely in jackets surrounding the barrels.—*September 4th*, 1922.

185,668. October 28th, 1921.—Furnace Doors, The Monkbridge Iron and Steel Co., Limited, Whitehall-road, Leeds, the Hon. R. D. Kitson, Roundhay Grange, and W. E. Brown, 1, Westbourne-villas, Ash-road, Headingley, Leeds.

In order to reduce the extent to which the furnace doors need be opened when railway tires are put in or drawn out from the

No 185,668



furnace, the inventors arrange to open the door both vertically and sideways. The tire A rests, as usual, against the inclined side of the furnace. The door B is hung from the cranked lever C by a rod and rests at the bottom on an inclined way. It will be seen that when the lever is pulled down the door will move upwards and to the right so as to permit the passage of the tire with a minimum amount of opening.—*September 14th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

185,673. November 4th, 1921.—Lathe Driving Gear, Hobbies, Limited, Dereham, Norfolk, and K. S. Jewson, Elvin Lodge, Dereham.

This lathe drive is intended for treadle or foot-driven machines and is effected by a chain and set of gear wheels. The chain A works over two sprocket wheels, which can be changed so as to increase or decrease the speed. To the spindle of the upper sprocket there is keyed the first wheel of a train of gears which

No 185,673

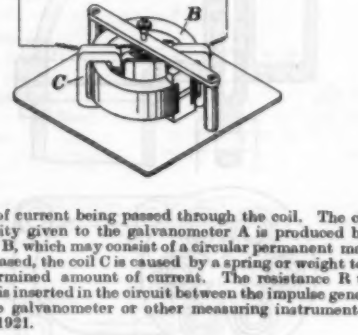
drives the mandrel. Only three toothed wheels are used to give combinations for six speeds, and the intermediate wheel B is mounted on a stud that can be moved to get the teeth of the wheels into mesh. These six speeds, together with the two changes offered by the chain, provide twelve speeds for the mandrel.—*September 14th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

185,569. July 8th, 1921.—Improvements in Instruments for the Measurement of Electrical Resistances, John Westmoreland Record, of "Hazeldene," Winton-road, Bowdon, Chester.

This specification describes a direct reading instrument with an arrangement which gives a predetermined quantity of current such as that produced by the limited movement of a conductor in a magnetic field. The instrument which measures the resistance is shown at A, the pointer being uncontrolled by springs and being free to stop in the position due to a certain

No 185,569



quantity of current being passed through the coil. The charge of electricity given to the galvanometer A is produced by the generator B, which may consist of a circular permanent magnet. When released, the coil C is caused by a spring or weight to give a predetermined amount of current. The resistance R to be measured is inserted in the circuit between the impulse generator D and the galvanometer or other measuring instrument A.—*July 8th*, 1921.

WELDING.

185,580. July 19th, 1921.—Electrodes for Arc Welding and Metal Cutting and Process for Making Same, William Hanson Boone, of Bush Lane House, Bush-lane, Cannon-street, E.C. 4.

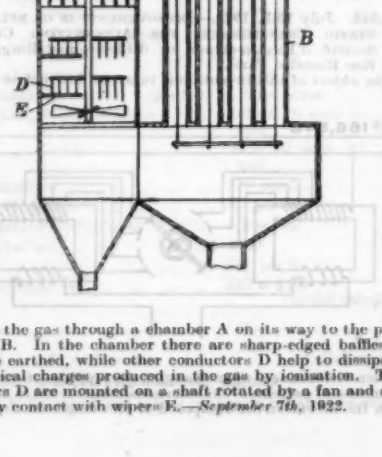
According to this invention the electrode comprises a metal rod or core wound with a carbonaceous fibre and covered by an extrusion machine with magnesite, aluminium and silicate of soda, the fibre being saturated with a saturated solution of biborate of sodium, and the winding and covering being effected whilst the fibre is wet with the solution. Crocidolite asbestos or amosite is included in the coating, and use may be made of graphite and granulated magnesium. The graphite should be not less than 98 per cent. carbon, and the crocidolite asbestos or amosite is blue amphibole asbestos containing about 51 per cent. silica and 38.5 per cent. ferrous oxide. All these materials used are intimately mixed and ground to a fine powder and then mixed so as to form a stiff paste with a solution of silicate of soda of a strength of 40 deg. The winding of the carbonaceous fibre is preferably effected transversely from end to end of the rod. The proportions of the materials used for the paste may be as follows:—Crocidolite asbestos, say 32 parts by weight; granulated aluminium, 1 part by weight; graphite (98 per cent. carbon), 2 parts by weight; calcined magnesite, 2 parts by weight. After coating, the electrode is dried, preferably in a current of hot air, and the wire or rod is bared at one end to about 1in. of metal for the purpose of making metallic contact in a suitable holder. After the arc is struck the electrode is held away from the workpiece.—*September 4th*, 1922.

MISCELLANEOUS.

185,315. August 17th, 1921.—Electrical Precipitation of Dust, *The Lodge Fume Company, Limited*, 51, *Great Charles-street, Birmingham*.

The inventors have found that the operation of electrical dust precipitation apparatus is considerably reduced if the gases from which the dust is to be taken have been raised to a high temperature, as, for instance, in an electric furnace. The difficulty is caused, they say, by the ionisation of the gas. They

No 185,315



thus pass the gas through a chamber A on its way to the precipitator B. In the chamber there are sharp-edged baffles C which are earthed, while other conductors D help to dissipate the electrical charges produced in the gas by ionisation. The conductors D are mounted on a shaft rotated by a fan and are cleaned by contact with wipers E.—*September 7th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Production Engineers.—Royal Automobile Club, Pall Mall, S.W. 1. Annual general meeting. Presidential address by Mr. M. R. Lawrence. 7.30 p.m.

The Institution of Mechanical Engineers.—Storey's Gate, St. James's Park, S.W. 1. General meeting. Presidential address by Dr. H. S. Hele-Shaw. 6 p.m.

The Junior Institution of Engineers.—39, Victoria-street, Westminster, S.W. 1. Lecturette, "Profits from Waste Products," by Mr. G. H. Ayres. 7.30 p.m.

Keighley Association of Engineers.—Devonshire Hall, Keighley. Social evening. Tickets, inclusive of supper, 3s. 3d. 7 p.m.

SATURDAY, OCTOBER 21st.

The Institution of Municipal and County Engineers.—The Guildhall Chambers, Dorchester. South-Western District Meeting. 12.15 p.m.

MONDAY, OCTOBER 23rd.

The Institution of Mechanical Engineers: Graduates' Section.—Storey's Gate, St. James's Park, S.W. 1. Paper, "Some Factors in the Design of Steam Locomotives," by Mr. R. D. Gauld. 7 p.m.

Institution of Automobile Engineers: Loughborough Centre.—The College, Loughborough. Paper, "Gear Ratios, with special reference to Epicyclic Train," by Mr. J. Bedford. 7 p.m.

TUESDAY, OCTOBER 24th.

The Institution of Automobile Engineers: Coventry Centre.—The Railway Hotel, Coventry. Paper, "The Light Car and Motor Cycle and Sidecar Compared," by Mr. W. H. Hingston. 7.30 p.m.

The Institute of Marine Engineers.—85–88, The Minories, Tower Hill, E. 1. Views illustrating industrial works, Messrs. Bruce Peebles. Ladies' night. 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland.—Rankine Hall, 39, Elmbank-crescent, Glasgow. Opening meeting. 7.30 p.m.

The Grantham and District Engineering Society.—The Co-operative Hall, Grantham. Paper, "The Steam Turbine," by Mr. C. F. Hewitt. 7.45 p.m.

WEDNESDAY, OCTOBER 25th.

Institution of Automobile Engineers.—Connaught Rooms, Great Queen-street, W.C. 2. Annual dinner. 7.30 p.m.

The Newcomen Society.—Prince Henry's Room, Fleet-street, E.C. 4 (nearest station, Temple, District Railway). Paper: "Simon Goodrich and His Work as an Engineer. Part I., 1796–1810," by Mr. E. A. Forward. 5 p.m.

FRIDAY, OCTOBER 27th.

The Institution of Mechanical Engineers.—Storey's Gate, St. James's Park, S.W. 1. Extra General Meeting. Adjourned discussion on the "Use of the Turbo-Compressor for Attaining the Greatest Speeds in Aviation," by Professor Auguste Rateau. 6 p.m.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Question and general discussion evening. 7.30 p.m.

Diesel Engine Users' Association.—The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. "The Care and Maintenance of Diesel Engines." Non-members desirous of attending the meeting can make application for tickets of admission to the Honorary Secretary at 19, Cadogan-gardens, S.W. 3. 3 p.m.

TUESDAY, OCTOBER 31st.

The Institution of Automobile Engineers.—The Broadgate Café, Coventry. Meeting of the Coventry Graduates. Paper: "Automobile Steels and their Heat Treatment," by Mr. S. Philpot. 7.45 p.m.

FRIDAY, NOVEMBER 3rd.

The Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Extra general meeting. Lecture on "Repairs to the Roof of Westminster Hall," by Sir Frank Baines. 6 p.m.

A Combustion Indicator.—A device by means of which, it is claimed by the makers, the efficiency of boilers may be improved has just been brought out by the Sanderson Bibby Company, Limited, 36–38, Kingsway, London, W.C. 2. It comprises a short length of tube, through which a draught of furnace gases is induced. A small electric lamp is arranged at one end of the tube and a window at the other. The fireman views the density of the smoke in the tube, and is thus able, it is said, to regulate his fire to the best advantage.

Steam Fire and Salvage Boat for Calcutta.—We have received details of the trials at Calcutta of a powerful steam fire and salvage boat supplied by Merryweather and Sons, of Greenwich, to the Calcutta Port Commissioners. The vessel was shipped in parts to Calcutta and fitted up locally at Messrs. John King and Co.'s shipyard at Howrah, under the supervision of a Merryweather engineer. The boat is named Alpha, and is built of steel throughout, under Lloyd's survey, Class A1. It has an overall length of 107ft. 6in., with a beam of 18ft. and a draught of 5ft. There are two horizontal water-tube marine boilers of a quick steam-raising type. The propelling engines are twin screw compound, of 525 indicated horse-power, and give the vessel a speed of 11 knots. The two fire and salvage pumps are of Merryweather's double-cylinder vertical "Greenwich" type, and have a combined capacity of 4000 gallons per minute. The boat is lighted throughout by a 100-volt steam-driven generating set, which also supplies current for a 24in. searchlight projector. The Chief Engineer of the Port Commissioners (Mr. J. McGlashan) and the Superintendent of Machinery (Mr. N. MacLeod) conducted the trials at Calcutta. After satisfactory speed tests the vessel was moored at the tea warehouse jetties and the pumps were put into action. Two large streams of water were then thrown to a height of 180ft., followed by single jets from 3in. and 3½in. nozzles. Thereafter twelve lines of hose were taken from the ship to the jetty, and an equal number of streams was discharged into the air. The Alpha was next taken to the tidal basin and twenty-four streams of water were thrown into the air simultaneously. The pumping capacity of the Alpha is equal to the combined power of ten land fire-engines.